STUDY OF NEUROVASCULAR ISLAND FLAP FOR RESURFACING THUMB DEFECTS

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CERTIFICATE

This is to certify the dissertation titled “Study of Neurovascular Island Flap for resurfacing Thumb Defects” was done under our supervision and is the bonafide work of Dr.B.A.Ramesh. It is submitted in partial fulfillment of the requirement for the Mch. Plastic Surgery Examination.

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CONTENTS

AIM OF STUDY

To identify outcome of Neurovascular island flap in our series with reference to:

- Etiology
- Age distribution
- Sex distribution
- Anatomical variation
- Procedure and modification to improve the result
- Sensory reorientation in our population and method of improvement
- Two point discrimination in our population and method of improvement
- Donor site disability
- Return of work

INTRODUCTION

Sensibility is essential to the normal function of the hand; in the thumb it is particularly important because each hand has only one thumb. If sensibility is lost, it can be said that the function of the hand is so impaired that it is as though the hand is "blind". Since the original work by Moberg (1964) on the sensory function of the fingers, many studies have reported on the treatment of nerve injuries and the evaluation of the sensory function. Dellon (1981) and Wynn Parry and Salter (1976) have aroused the attention of surgeons by reporting that special techniques of sensory re-education can result in improved sensation. However, it remains very difficult to measure sensation in a way which is quantitative, reasonably quick and easy to do, and which is related to function of the hand in real life.

The neurovascular island pedicle as suggested by Esser, predicted by Moran, promulgated by Bunnell, and presented by Littler and Tubiana is useful in bringing critical sensation to Thumb. Reconstruction of a large pulp defect is best accomplished by using durable tissue, preserving the glabrous nature of the tip and restoring its length, preventing symptomatic neuromas and adjacent joint contracture, minimizing aesthetic deformity, and retaining an optimal sensory innervations density. For fingertip reconstruction with an innervated sensory flap, V-Y advancement and the oblique triangular flap are most popular but are difficult to use in cases of extensive finger skin loss. Hemipulp free transfer and the first web free flap from the foot should be considered for these types of fingertip injuries, but

these methods are technically difficult and have associated donor-site defect problems. Although various reconstructive methods are available for large pulp defects, one-stage local island flaps are preferred to multistage regional flaps for reasons of cost, shorter hospitalization, and minimal disability time of the involved finger. The innervated reverse digital artery flap is one of the more useful homodigital island flaps for reconstruction of large pulp defects. However, this technique cannot be used to cover a thumb tip or the amputated stump of a middle phalanx, or in cases involving injury to the distal part of the middle phalanx, because it requires flap harvest from the proximal phalanx. The heterodigital neurovascular island flap satisfies these requirements but has the major disadvantage of cross-localization of sensation to the donor digit and hyperesthesia or paraesthesia of the donor digit.

A thumb reconstruction with pedicle covering alone has disadvantages of non-critical sensation and susceptibility to ulceration. Improved functional results are obtained when critical sensation and durability are secured by a neurovascular island flap. This supplemental measure sanctions the reconstruction of a thumb by pedicle and bone graft procedures.

This study presents follow-up results in forty two patients one to three years after neurovascular pedicle-flap operations. Study primarily interested in assessing the sensory acuity, the effect on cold intolerance, and the durability of the transfer in these patients. These are the major benefits ascribed to the operation. In addition, we noted the incidence and significance of factors that might impair or even nullify the function of the island. These included the lack of reorientation of stimuli, hyperesthesia, insufficient pulp padding, and donor-digit disabilities.

REVIEW OF LITERATURE

The neurovascular island pedicle flap is an accepted method of restoring sensation to a localized tactile area on the hand. Moberg first suggested this procedure as a means of restoring sensation following peripheral nerve injuries that cannot he repaired by direct nerve suture. The procedure has been used to provide sensation to the volar surface of pedicle flaps on the thumb and to replace pulp tissue avulsed from the thumb. The technique was developed and described by Littler and also by Tubiana and Dupare. The transfer consists of a flap of skin and pulp tissue from the ulnar half of the distal Part of the donor finger. The pedicle of this flap is the neurovascular bundle to the same side of the finger isolated as a single long stalk extending from its source in the palm distal to the flap. The neurovascular bundle acts as an umbilical cord to the flap and maintains both viability and sensation when the flap is moved subfascially to its new location. Donor site is covered with a free skin graft.

In the literature sensation in the pedicle flap has been described as “normal,” “critical,” and “comparable in quality to normal”. It has been suggested that the circulation in the recipient area is augmented by the additional blood supply of the flap with the result that cold intolerance is reduced and wound healing is improved. The operation also provides the durable sweat-producing, cornified skin that is so essential for thumb. While the technique has been well described the precise details of the functional properties already noted have not been recorded. Few complications or contraindications to the operation have been reported. It is

apparent that any stimulus applied to the transferred island will be interpreted by the patient as coming from the donor site and while, allegedly, cortical adjustment is readily achieved the actual length of time that may be required for this remains vague.

Littler, J.W.: Neurovascular Pedicle Transfer of island tissue in reconstructive Surgery of the hand. *In* Proceedings of the American Society for Surgery of the Hand. J. Bone and Joint Surg., 38-A: 917, July 1956.

Discussed the use of a neurovascular pedicle graft as a method of tissue transfer which permits a wide range of freedom without jeopardizing either circulation or sensation. The method is most applicable to the hand, for the neurovascular system of one part of the hand may be easily transferred to another part. When gross loss of the coverage and of the deeper structures of the forearm and hand are encountered, a direct pedicle flap, generally from the abdomen, is required for resurfacing. The purpose of this paper was to describe the use of local composite tissue, isolated and transferred on a neurovascular pedicle graft, in the restoration of vital areas rendered anaesthetic through irreparable nerve or soft-tissue damage, in the treatment of defects requiring limited pedicle-skin coverage, and in the reconstruction of a thumb through the transfer of a digit. In one case sensation had been restored to the index finger by means of a transfer from the ring finger. In another case reconstruction of the thumb had been done.

Aspects of Sensation in Reconstructive Surgery of the Upper Extremity ERIK MOBERG *J Bone Joint Surg Am.* 1964; 46:817-825.

The hand is tool: the arm is only the shaft. High quality sensory function for the tool is more than ever the key to good results in reconstructive surgery. Tests with **pinprick and cotton-wool applicators are too often quite unsatisfactory** and even misleading in the hand. **Reconstructive work should be based on the two-point-discrimination test, the picking-up test.** It has been shown by Littler and Tubiana amid Duparc, among others, that time old method of constructing a new thumb with a delayed flap from a distant donor area and a bone graft, if needed, may be of use, but only when tactile gnosis is added by a transfer of a neurovascular flap. Here is the place to emphasize **that detached flaps amid grafts never obtain tactile gnosis. The best they can get is protective sensation. This may sometimes be of use, but such sensation falls very far short of normal function and is quite insufficient for a precision sensory grip.**

Murray, J. F., Ord, J. V. R., and Gavelin, G. E. The neurovascular island flap: An assessment of late results in sixteen cases. *J. Bone Joint Surg. (Am.)* 49: 1285, 1967.

Sensation, circulation, and durability of neurovascular island flaps in the thumb were assessed in sixteen patients one to ten years after surgery. The incidence and significance of complications were noted. Based on two-point discrimination and touch, the sensation in the neurovascular island flap of these patients was less than normal when the flap was carried on a single pedicle. The **sensation was normal in one patient whose neurovascular flap comprised the whole volar surface of the donor finger supplied by both neurovascular bundles.** As a rule

the neurovascular flap provided an excellent durable tactile surface with sensation useful for gross grips. Cold intolerance did not appear to be affected by a neurovascular island transfer. Hyperesthesia occurred in seven of the sixteen patients for varying periods of time. It nullified the functional benefits of the operation. Reorientation of the localization of stimuli applied to the flap from the donor to the recipient site occurred in four patients only after long periods ranging from eighteen months to eight years. However, **function was not adversely affected if this reorientation had not occurred.**

Neurovascular Island Pedicle – Extension in Usage *J Bone Joint Surg Am.* 1962; 44:1069-1072. William H. Frackelton and Jack L. Teasley.

With traumatic loss of the terminal volar pad of a thumb or index digit,the neurovascular island pedicle can serve as an immediate or secondary replacement in preference to a free graft or cross- finger pedicle. A thumb reconstruction with pedicle covering alone has disadvantages of **non-critical sensation** and susceptibility to ulceration. Improved functional results are obtained when critical sensation and durability are secured by a neurovascular island flap. This supplemental measure sanctions the reconstruction of a **thumb by pedicle and bone-graft procedures.**

Objective methods for determining the functional value of sensibility in the hand erik moberg, gothenburg, sweden vol. 40b, no. 3, August 1958

A hand or part of a hand that lacks tactile gnosis, even if it possesses one or more of the aforementioned modalities of sensibility, is nevertheless " blind " that is, it cannot be used without the aid of the eye; it does not know whether or how it holds an object, or what the object is. Only by determining the tactile gnosis can a real idea be obtained of the value of the cutaneous sensibility for the precision-sensory grip. The functional value of the cutaneous sensibility in a hand, therefore, should be determined in the following way.

Tactile gnosis for precision-sensory grip-This can be determined objectively with the ninhydrin or iodine-starch printing methods. **Subjective methods that may be used as a complement are the two-point discrimination test,** Seddon's coin test and the picking-up test.

Sensibility necessary for gross grip-The presence of this function can be determined objectively by looking for **callosities** and similar signs of usage in the hand, and subjectively by testing the hand in use.

Protective sensibility-This must be judged from the history unless typical lesions show that it is absent

It was observed clinically that tactile gnosis varies directly with the sudomotor function in the hand. With the exception Grafts regain sudomotor function but never tactile gnosis.

Re-education of Sensation in the Hand Following Nerve Injury. DR. A. LEE DELLON, DR.RAYMOND M. CURTIS, and DR. MILTON T. EDGERTON

The functional level of sensation in a hand following repair of a severed nerve can be enhanced by deliberate re-education of the patient to interpret correctly the impulses obtained when the regenerated nerve is stimulated. In nine adult patients with twelve injured nerves, sensory exercises were instituted, consisting of constant handling of various shaped objects such as pencil eraser and various sizes of nuts and bolts, with and without visual coordination, for interpretation of both constant touch and moving touch. The patients learned to reassociate the altered sensation with what was happening at their finger tips. The exercises were performed several times a day. The authors reported that after three to four weeks on this program all patients with a digital-nerve lesion, either a lesion in continuity or a complete division with suture, had recovered normal or near normal sensation and that three patients with a sutured median or ulnar nerve recovered normal or near normal functional sensation in less than a year after nerve suture. It was suggested that **sensory re-education be made an integral part of the management of all peripheral nerve injuries.**

Restoration of prehension after severe mutilations of the hand Raoul Tubiana, Paris, France, H. Graham stack, London, England, and Robert w. Hakstian, Montreal, Canada.

Prehension is a complex mechanism for which both movement and sensation are required. Two basic grips are considered: the digital pinch and palmar grasp, which are simpler expressions of the precision grip and the power grip. For the digital pinch the minimum requirement is a thumb or a reconstructed thumb, and a finger to which it can oppose. For palmar grasp mobile fingers are necessary so that they can wrap round the object grasped. The restoration of prehension is considered under the following headings: mutilation of the fingers; mutilation of the thumb; and mutilation of both together. The various methods of reconstruction are described that are appropriate to each type of mutilation, so as to provide restoration of length, mobility and sensation.

The Neuro-Vascular Skin Island Transfer in the Hand-Assessment of Results. DR. JAMES F. MURRAY, DR. J. V. H. ORD, amid DR. G. E. GAVELIN

Had carefully assessed the results in sixteen patients in whom neurovascular skin island transfers had been done one to ten years prior to the examination using several variations in technique. All of the patients except a fourteen-year old had originally suffered injury during industrial work. In fourteen patients the transfers were done to provide a sensory area on the tactile surface of the thumb. There were no operative failures and all the transfers looked good. All had the normal rugae of volar skins and some were barely discernible from the surrounding pulp. There was less than normal sensation and no improvement in cold tolerance in the recipient

digit. The authors felt that the reduced sensory acuity indicated a reduced nerve supply in the transfer. They concluded from this series that a neurovascular island flap should not be used for primary repair of traumatic pulp losses because of the subjective symptoms. The patients' occupational needs, emotional stability, and intelligence cannot be properly assessed immediately after injury. In his discussion, **DR. ROBERT M. McCormack pointed out that the dominant indications for this procedure are impairment of sensation of the thumb and index finger and that the two-point discrimination test is emerging as the most reliable, and objective quantitative test for evaluating skin sensation.**

The Protective Value of a Neurovascular Island Pedicle Transfer in Hands Partially Anesthetic Due to Ulnar Denervation in Leprosy BY D. A. RANNEY, M.D., F.R.C.S., WATERLOO, ONTARIO, CANADA, AND W. M. LENNOX, F.R.C.S4, GLOUCESTER, ENGLAND.

Neurovascular skin island transfers were performed with the prime objective of protecting vulnerable anesthetic areas on the hands of patients with leprosy. After an average follow-up of eight years on sixteen patients, all had had long-lasting protective benefits without further loss of tissue consequent to injury. At follow-up, two-point discrimination was less than ten millimeters in only one patient, more than twenty millimeters in ten, and indeterminate in five. Sensory misreference persisted in fourteen patients. Axon sprouting was evident in six but only over short distances (four to eight millimeters beyond the island). Compared with the intact side of the donor finger, nine of the sixteen transfers had lost some sensitivity but sensation was rated normal in one, nearly normal in six, and protective only in nine. The loss of sensation in the donor finger was less than expected and was not a problem. Scar

contracture occurred in two donor and five recipient fingers, but this could be attributed to placement of the incision too far anteriorly, and hence was an unavoidable complication. Restoration of protective sensation to the ulnar border of the hand, whatever the cause of anesthesia, is considered extremely worth while.

Radial-Innervated Cross-Finger Flap from Index to Provide Sensory Pulp to Injured Thumb. J. STUART GAUL

The radial-innervated cross-finger flap offers a large and relatively expendable donor area of innervated dorsal skin for reconstruction of the volar surface of the thumb; it deprives no finger of its perceptive ability and protective volar sensation. The island pedicle flap taken from a normal finger is a much more expensive source of tissue. How-ever, if a finger is sufficiently damaged, then an island-pedicle flap is considered available. Under such circumstances this method should be used to reconstruct the thumb; the remainder of the donor finger is amputated. Conditions determining availability are discussed. Despite the availability of an island flap, other circumstances may indicate the use of the radial-innervated cross-finger flap. These include: the surgeon’s lack of experience with neurovascular pedicle tissue transfer, the age of the patient, the magnitude of the area of thumb defect, and the presence of hyperesthesia in the thumb at the time of surgery. **In total avulsion of the thumb pulp, the radial-innervated flap alone is not adequate because it will not provide the needed thickness of subcutaneous tissue.**

Osteoplastic Reconstruction of the Thumb

Osteoplastic procedures reconstruct a thumb with the aid of a bone graft covered with a skin flap, raised either locally or at a distance. Although the idea for this method was probably Nicoladoni's (1900), it is unlikely that he ever carried out the complete operation because his three patients all refused the bone graft necessary to support the skin flap stage. According to Carcassonne (1930) it was Noesske (1909) who completed the first reconstruction, using a thoracic tube and a tibial bone graft.

Osteoplasty constitutes one of the least destructive procedures in respect of the rest of the hand. It previously presented two serious disadvantages which often restricted its use by the patient: the frequency of resorption of the bone graft, and the occurrence of atrophic skin changes. These problems are due to defective vascular and nerve supply, and the absorption of the bone graft may be a disuse phenomenon consequent upon lack of sensation.

In order to avoid these complications, in the past, bone grafts were kept short and were covered when possible by local skin flaps which provided a certain degree of sensibility. These flaps can be raised from the base of the thumb and advanced distally, as in the Gillies and Millard (1957) "cocked hat" procedure, or they may be raised from the dorsum of the hand or index finger. They permit the reconstruction of a thumb of restricted length, with the limited sensibility of dorsal skin. A maximum increase of length of about one inch can be obtained by this method. A technique is now employed which gives a thumb with good sensibility, and with a minimum of atrophic change. The special feature of this method is the combination

of a tubed pedicle flap with a sensory skin island transfer (Tubiana and Duparc 1960). The operation embodies the general technique of heterodigital neurovascular island transfer, as developed by Moberg (1955) and Littler (1960), but applies it further to a particular situation.

Further experience with the bipedicled neurovascular island flap in thumb reconstruction. J Hand Surg [Am]. 1991 Jul; 16(4):594-7. Paneva-Holevich E, Holevich Y.

A procedure is described for the transfer of sensibility to the thumb by means of an island flap. The donor site is the dorsoradial surface of the index finger. The flap is supplied by two neurovascular pedicles. The palmar one includes the digital artery of the index and the dorsal branch of the palmar digital nerve. The dorsal pedicle includes the dorsoradial artery and nerve of the index and one or two superficial veins. This procedure was used in 29 patients without early postoperative complications. **The advantages of the method are the resurfacing of the prehensile surface of the thumb by a flap with good arterial and venous supply while preserving the innervations and the palmar skin of the donor finger.**

The neurovascular island pedicle flap. Acta Orthop Scand. 1979 Feb; 50(1):67-71 Boe S.

Nine patients with irreparable damage to the nerves of the thumb, treated with a neurovascular island pedicle flap from the third or fourth finger to the defect thumb, have been re-examined 9 months to 8 years after the operation. Eight patients had a 2-point discrimination of less than 15 mm corresponding to the flap and all had a positive Ninhydrin test. Two had complete cortical reorientation and three

partial reorientation. Six found the function of the thumb to be good or fair. Three described the result as poor and three had to be reoperated because of contractures of the donor finger and/or thumb. The method can be recommended for use in young, well motivated patients.

Thumb reconstruction using a neurovascular pedicled island flap. Zhonghua Zheng Xing Shao Shang Wai Ke Za Zhi. 1989 Dec; 5(4):246-8, 315.Hou CL.

Since June 1983, seven kinds of neurovascular pedicled island flaps have been applied for thumb reconstruction in 14 cases with satisfied results. The donor flaps were from dorsum of index finger in 4 cases, from radial aspect of index in 3 cases, from both the dorsum and the radial aspect of index in 2 cases, from the dorsum and radial aspect of the index finger and the radial aspect of long finger in 2 cases, from the ulnar aspect of the index and the radial aspect of long finger in 2 cases, and from the radial aspect of forearm in 1 case. In other case, the thumb was reconstructed by an osteocutaneous flap arising from radial aspect of forearm. The procedures are faster, simpler and safer than the microsurgical flap transfer: the contour and function are better than those of traditional tube-pedicle graft.

The neurovascular island flap for defective sensibility of the thumb. : J Bone Joint Surg Br. 1975 Nov; 57(4):495-9. Krag C, Rasmussen KB.

In six patients with defective sensibility of the thumb the transfer of a neurovascular island flap was performed according to Littler's technique. This review one to eleven years later was mainly to determine if reorientation of the cortical representation of stimuli had developed and if tactile gnosis had persisted. The pick-up test was carried through by the three patients with a lesion of the

dominant hand. All six patients referred pin-prick in the flap to the donor finger; all had absent two-point discrimination corresponding to the flap, although it had been present within normal limits a few months after operation; and all had better touch, pain and temperature sensibility in the flap than in the surrounding recipient area. All six reported functional improvement. **For the best results an intelligent patient is required who has a lesion of the dominant hand and is prepared to use or exercise it regularly.**

Long term follow up of neurovascular island flaps. Hand. 1980 Jun; 12(2):113-22. Henderson HP, Reid DA.

The results of a ten year mean follow up of twenty Neurovascular Island Flaps and two Radial Nerve Innervated Cross Finger Flaps are presented. Sensory acuity sufficient for tactile gnosis was achieved in nineteen cases. In only one case had sensory acuity deteriorated since operation. Use of the flap was hampered in one patient by a pre-existing neuroma. Complete sensory reorientation occurred in five patients. Sensory misreference persisted more commonly on dominant hands. It was our impression that Porter's Letter Test revealed the patients making most use of their neurovascular island flaps. The place of neurovascular island flaps in the management of the mutilated hand is discussed.

A neurovascular island flap for volar-oblique fingertip amputations. Analysis of long-term results. J Hand Surg [Br]. 1996 Feb; 21(1):94-8.Tsai TM, Yuen JC.

A neurovascular island flap has been developed to reconstruct volar-oblique fingertip amputations. This study analyzes the data collected on 16 patients who were treated with this flap and had at least 2 years follow-up. The average active/passive range of motion was 54/55 degrees at the DIP joint, 96/98 degrees at the PIP joint, and 83/83 degrees at the MP joint. Twelve out of 16 flaps (75%) had two-point discrimination better than 10 mm. Moderate and severe problems included cold intolerance (six patients), hypersensitivity (three patients), stiffness (three patients), and numbness (two patients). Out of the 16 patients treated with this technique, 14 were satisfied with their surgical outcome**. In experienced hands, this technique is a safe and reliable method with which to reconstruct volar-oblique fingertip amputations.**

The hatchet flap for reconstruction of fingertip amputations. Plast Reconstr Surg. 2006 May; 117(6):1933-9. Tuncali D, Barutcu AY, Gokrem S, Terzioglu A, Aslan G.

BACKGROUND: Emmett has described a single triangular flap that contains a partial skin bridge on one of its sides and called it the hatchet flap. It was successfully used for defects located on various body parts. The aim of this study was to present the authors' experience and results obtained with this flap in fingertip amputations. METHODS: Nine patients who have completed their 1-year follow-up period were included in the study. Two-point discrimination and stiffness were

tested, and the patients were queried about the existence of cold intolerance, hypersensitivity, numbness, and pain in the early (3 months) and late (1 year) postoperative periods. RESULTS: The amputations were located on the thumb in three patients, index finger in one patient, middle finger in three patients, and ring finger in two patients. The average defect size was 2.1 x 1.5 cm. Partial wound dehiscence was observed in one patient. The flap has provided good protective padding and aesthetic contour for the fingers. All incisions healed with inconspicuous scars. Average two-point discrimination was 6.3 mm (range, 4 to 8 mm). Cold intolerance was observed in two (22.2 percent) and paraesthesia in one patient (11.1 percent). Joint stiffness was not noted. Most patients could return to their normal routine in approximately 4 to 5 weeks. CONCLUSIONS: The hatchet flap is a good alternative for transverse and lateral oblique fingertip amputations and valuable for volar oblique amputations (defects <2 cm) with more extensive flap designs. The technique is simple and safe and provides good protective padding and acceptable tactile gnosis.

Neurovascular island flap by the disconnecting-reconnecting technique. Adana R, Pancaldi G, Castagnetti C, Zanasi S, Squarzina PB. J Hand Surg [Br]. 1990 Feb; 15(1):62-5

The authors report nine cases of hetero-digital neurovascular island flaps raised by the "disconnecting-reconnecting" technique for defects of the tactile pad of the thumb. At an average follow-up of 25 months, all cases had good restoration of sensibility without any "double sensibility" phenomenon and patients regained good dexterity. No tender neuroma developed and donor site complications were not troublesome.

Restoration of function and sensitivity utilizing a homodigital neurovascular island flap after amputation injuries of the fingertip. J Hand Surg [Br]. 2005 Aug; 30(4):338-42. Varitimidis SE, Dailiana ZH, Zibis AH, Hantes M, Bargiotas K, Malizos KN.

Sixty-three fingertip amputations in 50 patients were reconstructed using a homodigital neurovascular island flap technique based on a single neurovascular pedicle without further shortening of the distal phalanx. The procedure was carried out under regional anaesthesia, using a tourniquet and magnifying loupes. All of the flaps survived and achieved normal or adequate two-point discrimination without any painful scar or cold hypersensitivity. Fifteen patients had some loss of distal interphalangeal joint extension. The technique is simple and presents an excellent method for fingertip reconstruction in Allen type II, III and IV injuries.

Local neurovascular island flap. J Hand Surg [Am]. 1990 Sep; 15(5):798-802 Cook FW, Jakab E, Pollock MA.

Fingertip amputation, with loss of the terminal pulp and bone exposure presents a difficult problem. Reconstruction with use of a local neurovascular island flap has been done in twenty-one patients to restore sensibility and function with preservation of length. All patients achieved two-point discrimination values within two millimeters of the normal contra lateral fingertip, with adequate pad for pain-free pinch. We advocate this procedure for deep pulp loss over the distal phalanx. It is reliable, single-staged, and provides skin coverage closer to normal than any regional flap technique.

Neurovascular island skin flaps in the hand: functional and sensibility evaluations. Microsurgery. 1987; 8(3):162-7 Stice RC, Wood MB.

The value of neurovascular island skin flap transfers for digit tip surfacing has been evaluated in 13 patients. A computer assisted sensory evaluation was carried out on six of the patients. All patients were satisfied with the procedure. Sensory acuity did not appear to diminish with time and sensory misreference was not a major functional problem. We suggest that the neurovascular island flap, when available, is still an excellent procedure for restoration of useful digit tip sensibility.

Reconstruction of the insensate thumb by neurovascular island transfer. Hand Clin. 1992 Feb; 8(1):99-105. Thompson JS.

A carefully planned and performed interdigital neurovascular island transfer offers the potential of excellent vascularized sensate coverage for the thumb. **The procedure has stood the test of time and remains an important procedure in the armamentarium of the reconstructive hand surgeon.**

Hueston's flap for reconstruction of loss of distal thumb substance Foucher G, Debry R, Van Genechten F, Merle M. Ann Chir Main. 1985; 4(3):239-41.

The classical rotation flap described by J. Hueston involves the advancement of a denervated skin area on the distal stump. In distal amputations of the thumb, this flap should only be used on the lateral side in order to avoid creating a blind medial pulp. Furthermore, this leaves a proximal skin defect thereby exposing the neurovascular bundles. This secondary defect is best covered by a lateral triangular rotation flap.

Coverage of the degloved thumb with twin Neurovascular Island flaps: a case report. Br J Plast Surg. 1986 Apr; 39(2):255-6. Chen H, Noordhoff S.

A simple and useful method is described for resurfacing a distal phalanx of the degloved thumb with twin neurovascular island flaps from the ulnar and radial aspects of the middle and ring fingers respectively. It provides protective sensation and an acceptable cosmetic result.

Sensory function of the neurovascular island flap in thumb reconstruction: Comparison of original and modified proceduresYoshinori Oka, MD J Hand Surg 2000; 25A:637-643.

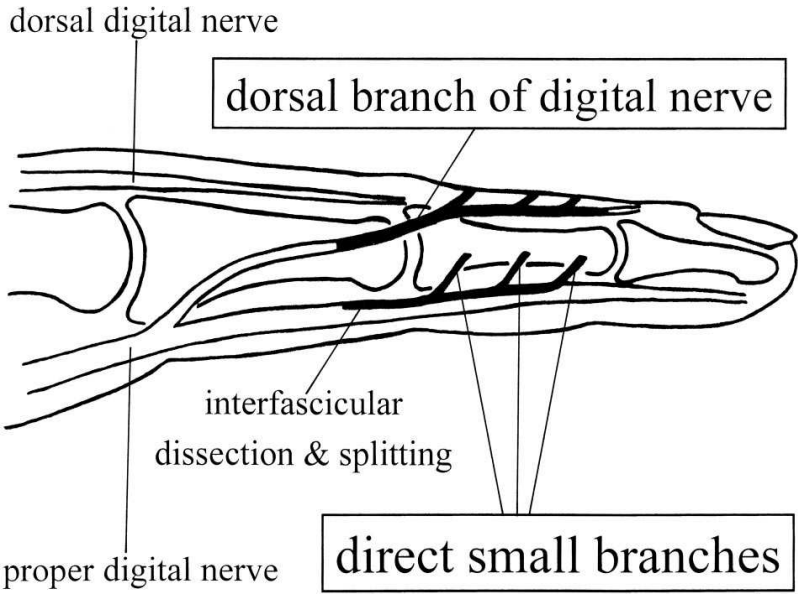
A study was conducted to examine the sensory function of thumbs that were reconstructed using 2 procedures: the original Littler neurovascular island flap (NVIF) procedure and a modification of the NVIF procedure in which the divided nerve of the transferred island flap is sutured to the original nerve of the thumb. Twenty-one patients with a mean follow-up period of 4.6 years were examined. Nine patients were treated with the NVIF procedure and 12 with the modified NVIF procedure. Paraesthesia was observed more frequently in the patients treated with the original NVIF procedure. The Semmes-Weinstein test and the static and moving 2-point discrimination examinations showed no significant difference between the 2 groups. The pulp writing test showed significantly better results for the patients treated with the modified NVIF procedure. The transferred pedicle flap was fully recognized as representing the thumb in the modified procedure. In the original procedure, however, the sensibility of the transferred pedicle flap was recognized as coming from the thumb in only 61% of the cases; furthermore, the original

procedure carried an additional disadvantage in that sensibility of the transferred pedicle flap was recognized as coming from both the donor and recipient sites.

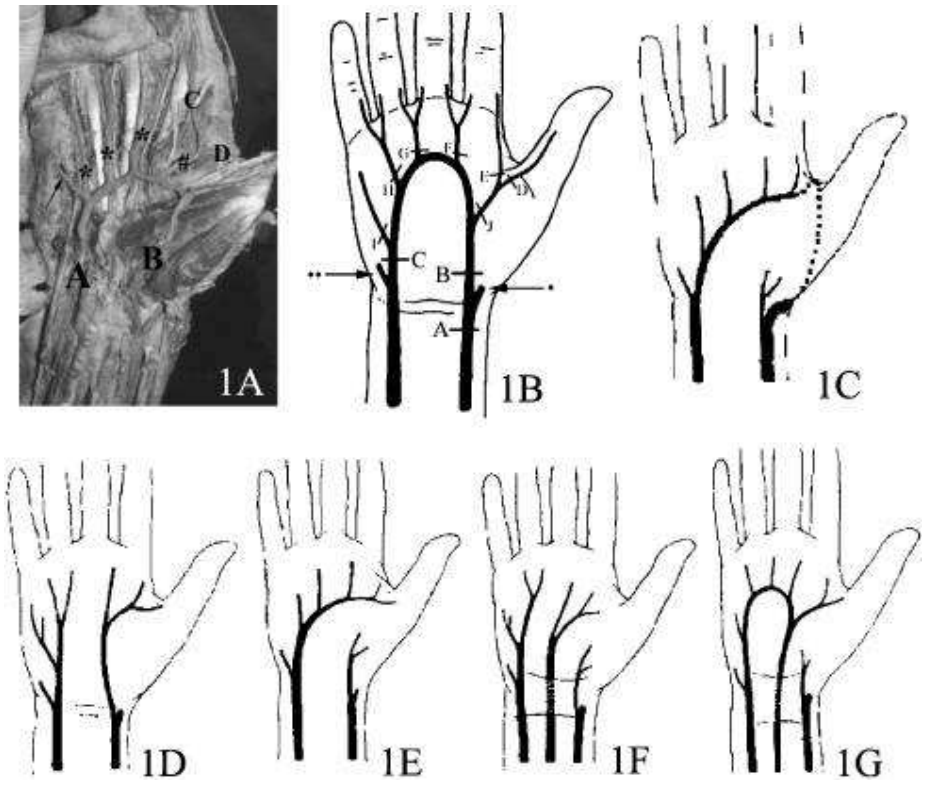
Innervated Lateral Middle Phalangeal Finger Flap for a Large Pulp Defect by Bilateral Neurorrhaphy Young Ho Lee, M.D. Goo Hyun Baek, M.D. Hyun Sik Gong, M.D. Sang Min Lee, M.D. Moon Sang Chung, M.D. *Seoul, Korea* PRS OCT 2006.

The heterodigital innervated lateral middle phalangeal finger flap supplies glabrous skin with near normal sensibility. In particular, by preserving the digital nerve in continuity in the donor finger, the donor finger retains a normal sensate pulp. Unlike the heterodigital neurovascular island flap, the digital nerve is left in situ in the donor finger, thus avoiding many technique-associated neurologic complications, most of which can be attributed to digital nerve severance. A one nerve fascicle from direct small branches of the proper digital nerve and a dorsal branch of the proper digital nerve were used for maximal sensation in our innervated lateral middle phalangeal finger flap. Furthermore, the two digital nerve coaptations implemented at the recipient site may have prevented the development of painful neuroma of the recipient finger caused by an unrepaired digital nerve stump. The dorsal branch of the proper digital nerve passes either deep or superficial to the proper digital artery and courses obliquely to innervate mainly the ipsilateral dorsal skin of the middle phalanx. The dorsal half of the innervated lateral middle phalangeal finger flap is innervated by this dorsal branch. The volar half of the innervated lateral middle phalangeal finger flap is presumably innervated by direct small branches of the proper digital nerve, because we observed that the direct small branches run from the proper digital nerve to the volar half of the flap in all cases on

the operating microscopic field. The distinction in static twopoint discrimination between the radial half of the reconstructed area and the ulnar one was not found in all evaluated flaps on long-term follow-ups exceeding 12 months. There was no patch nerve recovery. The donor finger of the innervated lateral middle phalangeal finger flap was cosmetically good compared with the dorsal middle phalangeal finger flap, because the grafted skin was hidden by the adjacent finger, and because this technique uses tissue of the lateral aspect of the middle phalanx, thus allowing fingerprint similarity. However, there are some obstacles. This flap has a potential risk of venous congestion, and a delicate dissection technique is another requirement for success. Despite these disadvantages, we believe that an innervated lateral middle phalangeal finger flap, with bilateral neurorrhaphy, could be included as a surgical technique for the reconstruction of major pulp defects when return of sensation is critical and other flaps are inappropriate.



Example of a right superficial palmar arch, as classically described in the literature, showing all the branches. A, ulnar artery; B, superficial branch of the radial artery to the superficial palmar arch; C, radial index artery, as a branch of the 1st common digital artery (#); D, princeps policis artery as a branch of the 1st common digital artery (#). Asterisks indicate the 2nd, 3rd and 4th common digital arteries. Arrow indicates the digitus minimus artery. (B) Schematic drawing of a left superficial palmar arch. A, radial artery; B, superficial branch of the radial artery to the superficial palmar arch; C, ulnar artery to the superficial palmar arch; D, princeps policis artery as a branch of the 1st common digital artery (J); E, radial index artery, as a branch of the 1st common digital artery (J); F, 2nd common digital artery; G, 3rd common digital artery; H, 4th common digital artery; I, digitus minimus artery. (C) The most common variation reported here: note the presence of a small radial artery branch to the arch (dashed line) that arose dorsally and passed into the palm to reach the ulnar artery. (D) An incomplete superficial palmar arch, with contributions from both ulnar and radial arteries. (E) An incomplete superficial palmar arch formed only by the ulnar artery. (F) An incomplete superficial palmar arch in which the median artery substitutes the radial artery vascular territory. (G) A superficial palmar arch in which the median artery substituted the radial artery to complete the arch.



Anatomical landmarks to the superficial and deep palmar arches.McLean KM, **Sacks JM**, **Kuo YR**, **Wollstein R**, **Rubin JP**, **Lee WP**. Division of Plastic and Reconstructive Surgery, University of Pittsburgh, Pittsburgh, PA 15261, USA.

BACKGROUND: Knowledge of the relationship of the palmar arches to anatomical landmarks would decrease iatrogenic injuries, facilitate treatment of vascular occlusive disease, and ease interpretation of abnormal arteriograms. The purpose of this study was to identify the location of the palmar arches in relation to surface and bony landmarks. METHODS: The

palmar arches in 48 cadavers were identified through dissection. The most distal points of the palmar arches were measured in relation to Kaplan's cardinal line, the distal wrist crease, and the carpometacarpal joint of the ring finger. The distances of the palmar arches to the radiocarpal joint were measured on 30 arteriograms. RESULTS: The superficial palmar arch and deep palmar arch were found to be on average 15.3 +/- 8.60 mm and 6.70 +/- 4.82 mm distal to Kaplan's cardinal line, respectively. The superficial palmar arch was found to be on average 51.8 +/- 7.56 mm distal to the distal wrist crease, while the deep palmar arch was only 40.1 +/- 7.92 mm from the distal wrist crease. The average distances from the superficial palmar arch and deep palmar arch to the carpometacarpal joint of the ring finger were 32.2 +/- 6.33 mm and 18.3 +/- 4.64 mm, respectively. On arteriography, the superficial palmar arch and deep palmar arch were on average 50.3 +/- 8.61 mm and 44.89 +/- 4.77 mm, respectively, from the radiocarpal joint. CONCLUSIONS: The superficial and deep palmar arches were located at consistent distances from easily identifiable surface and bony landmarks. Knowledge of these predictable anatomical relations would aid clinicians in surgical dissection, treatment of vascular occlusive disease, and interpretation of abnormal arteriograms when only one arch is present.

Association of the absence of palmaris longus tendon with an anomalous superficial palmar arch in the human hand

Elizabeth O'Sullivan and Barry S Mitchell J Anat. 2003 February; 202(2): 253.

Our findings indicate that if the palmaris longus tendon was absent then in 47% of the hands it was associated with an abnormal SPA. In the remaining 40% of the hands we examined, where the palmaris longus tendon was present, this was associated with the presence of a normal SPA. The observations of the 6.5% of hands where an anomalous SPA was found associated with a palmaris longus tendon, and the 6.5% of hands where a normal SPA was found with no palmaris longus tendon do not significantly weaken the overall predictive power of this simple method. Indeed, in statistical analyses of the total number of hands examined in the present study there was a highly significant difference between the proportion of hands with an anomalous arch and no palmaris longus tendon compared to the proportion with anomalous arches and with a palmaris longus tendon. This simple test offers a significant improvement when used in conjunction with the current clinical techniques.

Arterial anatomy of the thumb. Ames EL, **Bissonnette M**, **Acland R**, **Lister G**, **Firrell J**. J Hand Surg [Br]. 1993 Aug;18(4):427-36. Christine M. Kleinert Institute for Hand and Micro Surgery, Louisville, Kentucky.

The anatomical literature has indicated that the arterial supply to the thumb comes from the princeps pollicis artery. However, this simplified description does not often correlate with intraoperative findings. The purpose of this study was to investigate and clarify this important area of anatomy by dissection of fresh cadaver hands. 40 dissections were completed on 35 intravascularly injected and five non-injected hands. Five patterns were identified. The most common pattern showed both a superficial and deep vessel to the first web space in 54% of specimens. Dominant vessels included the superficial palmar branch of the radial artery in 8%, first palmar metacarpal artery in 18% and dorsal metacarpal artery in 8%. Only three specimens correlated with the textbook description. We conclude that the term "princeps pollicis" is actually a misnomer.

Arterial system of the fingers. J Hand Surg [Am]. 1990 Jan;15(1):148-54.**Strauch B**, **de Moura W**.Department of Plastic and Reconstructive Surgery, Montefiore Medical Center, Bronx, N.Y.

The arterial system in 141 fresh human cadavers was studied under the operating microscope using magnifications of 8 to 25 times. The vascular system was injected with latex material alone for identification of the vessels

during dissection, and with latex and lead for x-ray contrast studies. An overall repetitive pattern in size, location, and distribution of the vessels was noted. The dorsal branches of the paired digital vessels in each phalanx were generally 4 and demonstrated a regular, repetitive distribution corresponding to: a, condylar vessel; b, metaphyseal vessel; c, dorsal skin vessel; and d, transverse palmar arch. Proximal and middle transverse palmar arches were found always in relation to the cruciate ligaments. The distal transverse palmar arch lay just distal to the insertion of the profundus.

The palmar digital venous anatomy. Scand J Plast Reconstr Surg Hand Surg. 1990;24(2):113-9. **Nyström A**, **von Drasek-Ascher G**, **Fridén J**, **Lister GD**. Department of Hand and Plastic Surgery, University of Umeå, Sweden.

Fresh human cadaveric hands were injected with a liquid plastic polymer and dissected under the operating microscope. On the palmar aspect of the digits, four different venous patterns could be identified, characterized by their tributaries and branching pattern, and by the presence, position and direction of valves. Arborized veins drain a limited volume of tissue by a number of very slender vessels that come together to form a common trunk. Venous arches are found both superficial and deep, palmar and lateral; they neither branch nor have valves, except at both ends. Deep axial veins accompany the digital arteries as comitant veins. They drain to both the metacarpal comitant veins and the web space veins. Superficial axial veins

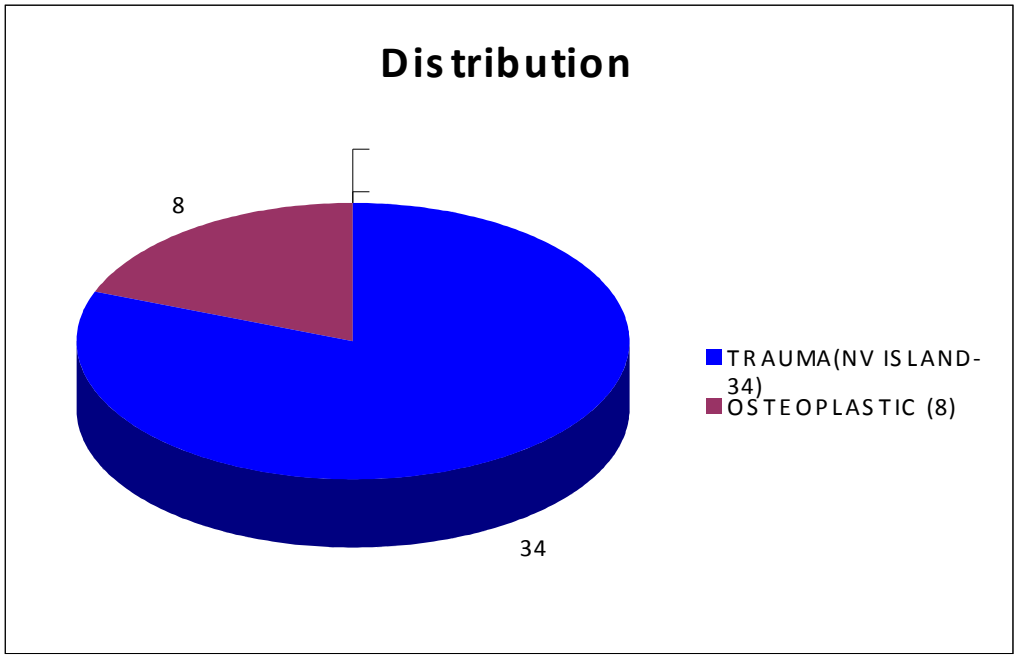
run principally in the subdermal layer of the finger; they drain either directly to dorsal veins or to the natatory vein on the ligament of the same name.

The dorsal branch of digital nerve: An anatomic Study and Clinical Applications. Ali teoman Telliglu., MD, Omer Sensoz., MD Annals of Plastic Surgery vol 40 Feb1998

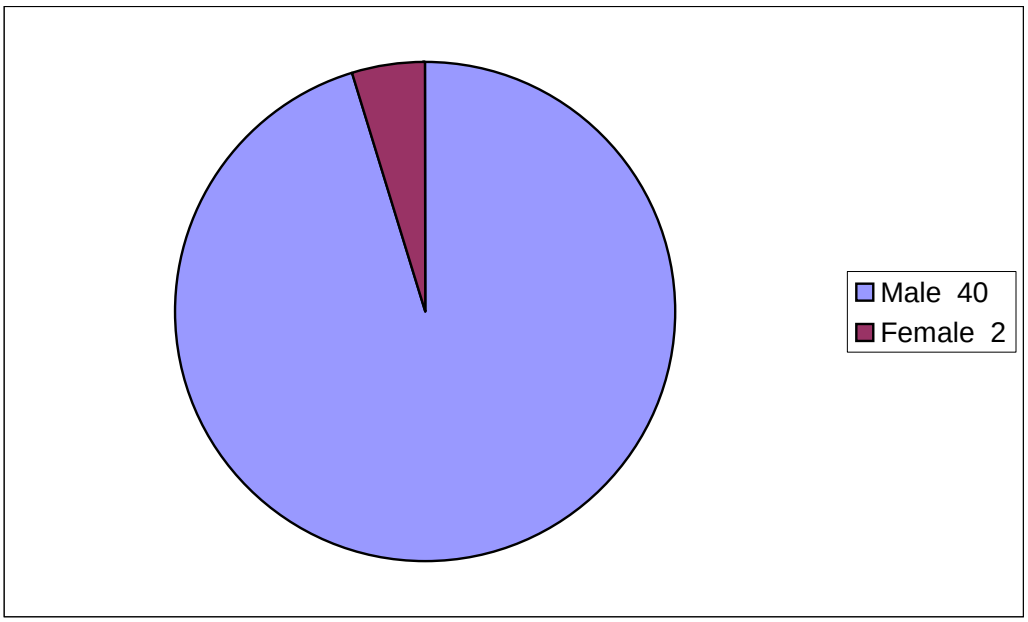
The dorsal branch of the digital nerve was studied in 40 fingers from 8 cadavers. Anatomic dissections showed that the dorsal branch of all digital nerve was constantly present. It arose from the digital nerve at the base of the proximal phalanx where digital vascular bifurcation usually occurred. The dorsal branch crossed the digital vascular bundle posterior and lay just above the extensor mechanism deeper to the dorsal-sensitive branches of the ulnar and radial nerves in the proximal and middle part of the proximal phalanx. Every digital nerve had a constant dorsal branch that not only supplied the dorsum of the middle phalanx but also sent a branch to the digital nerve coursed deeper to the dorsal-sensitive branches of the ulnar and radial nerves. When the dorsal branch is used for cross-finger flap innervations, the risk of painful neuroma is minimal. The dissections of the dorsal branches may be started proximally from distal palmar crease when any difficulties are encountered for nerve isolation. Nerve stumps of the dorsal branches should be placed in a deeper tissue plane and epineural sutures may be useful to prevent painful neuroma. This technique should be used in selected patients to gain maximal sensibility regarding the described.

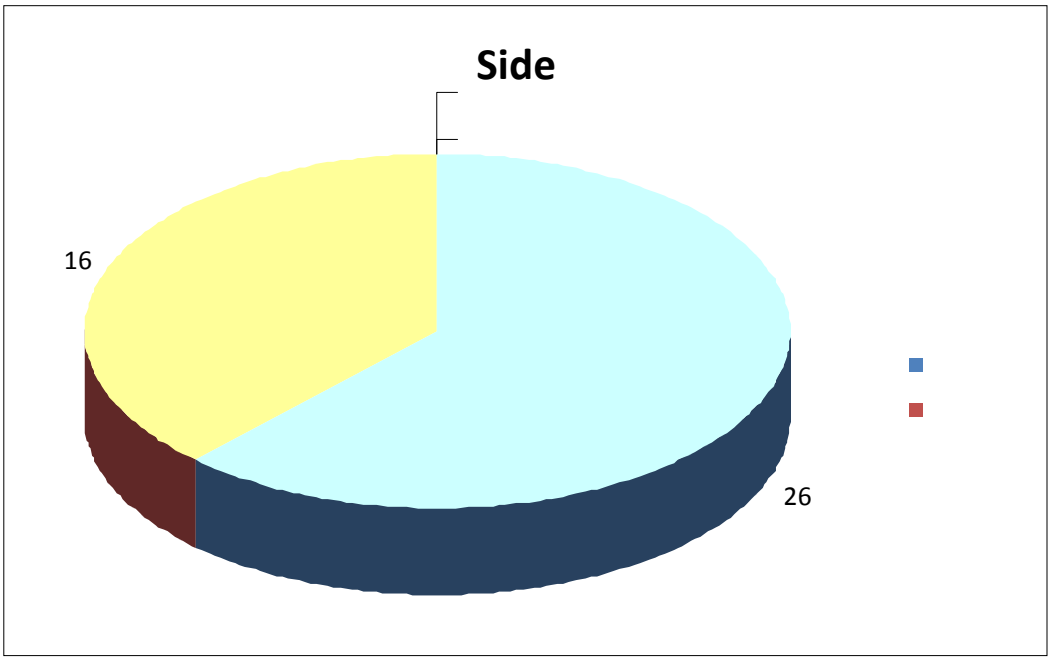
MATERIALS AND METHODS

Forty two patients were operated. Two patients were females and the rest were males. The age of the patients ranged from nine to fifty-five years. Except for the three young patients aged less than 18 years all were industrial injuries. Of these three patients two had accidental electrical injury to thumb terminal phalanx and the other sustained accidental injury with knife. All patients were right handed. Sixteen patients were operated on nondominant hand (i.e. Left hand). Eight patients underwent osteoplastic reconstruction and the rest of the cases were operated for soft tissue loss on thumb. The follow-up period was for every 6 months for all patient for 2 years.



Sex Distribution





Right thumb was commonly injured.(R:L=26:16)

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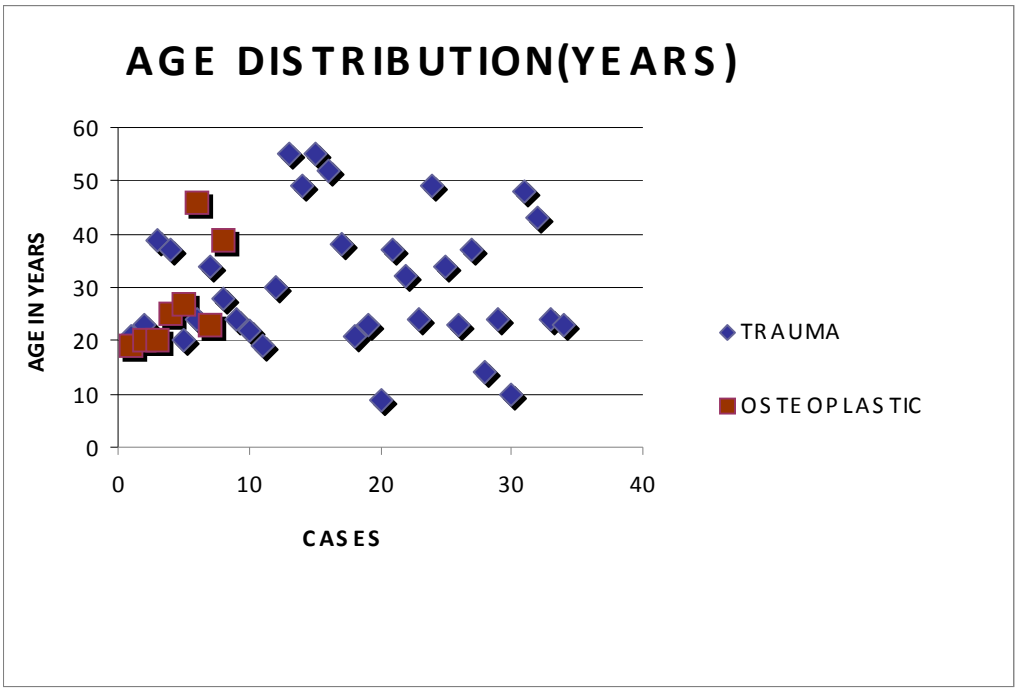
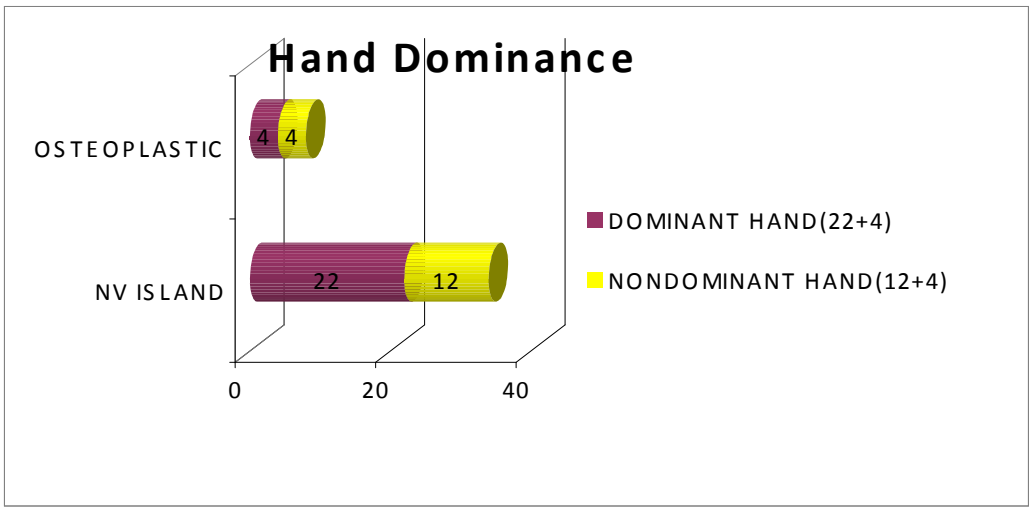
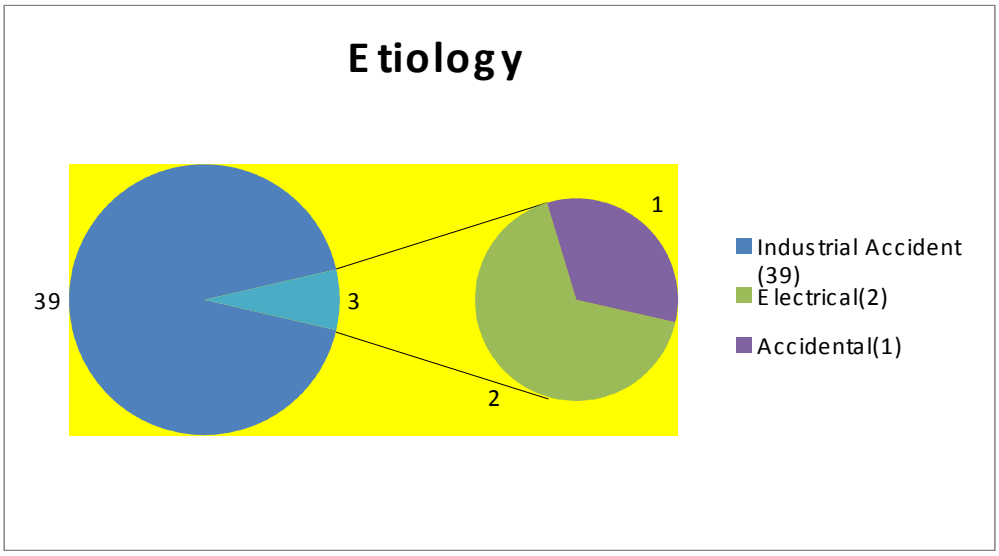


MOST COMMON AGE GROUP AFFECTED IS 20 TO 40 YEARS





Indications for Neurovascular Island Flap:

1. Soft tissue loss over terminal phalanx of thumb with intact nailed and dorsal skin. – 32 cases
2. Soft tissue loss over Proximal Phalanx with loss of digital nerve - 2 cases
3. Osteoplastic thumb reconstruction – 8 cases

Operative Procedure:

A digital Allen test was performed on the donor digit to ascertain the adequeacy of perfusion of each proper digital artery. Palmaris longus tendon was tested and present in all our cases. The operation was conducted with the patient under regional block or general anesthesia, and was performed under pneumatic

tourniquet control, which is inflated with the upper extremity elevated but not completely exsanguinated. After Squaring of the defect, a horizontal line from the ulnar margin of the outstretched thumb (Kaplan line) was marked on the palm and a vertical line was drawn from the ulnar side of the donor finger marked. Defect Measurement (2/3cm) was taken on lint piece and planning in reverse done. The donor site was skin and subcutaneous tissue over the ulnar half of the terminal phalangeal region and middle phalangeal region or over the middle phalangeal region and proximal phalangeal region of the ring or middle finger. This flap was centered on the midlateral line of the donor finger and extended from the middorsal line to the midpalmar line. A Brunner's palmar zigzag incision was drawn, and the skin incision was continued proximally. This incision and the dissection of the vascular pedicle was carried out into the palm to the level of the proximal part of common digital artery, and if required, to the superficial palmar arch to transfer the flap to the recipient site without tension. With the 3.3X surgical loupe magnification, the vascular pedicle was then carefully separated from the proper digital nerve and was dissected en bloc with the surrounding soft tissue. At times proper digital nerve looped around neurovascular bundle with fat and needed careful release. In six cases dorsal branch of digital nerve was preserved by splitting the nerve from the neurovascular bundle up to the pivot point to preserve sensation on the donor finger. Digital artery to the ring or adjacent finger was isolated, ligated and divided. Communicating branch to the dorsal metacarpal artery was identified at the neck of metacarpal and cauterized. Flap was elevated above FFS on volar side and above the extensor paratenon on dorsal side. A subcutaneous tunnel was created between the donor and recipient sites. (Littler 1960) Tunnelling was performed from

the proximal edge of the recipient site into the palm to reach the pivot point. As the flap passes through the tunnel, care was taken to ensure that the digital artery and perivascular soft tissue were not kinked. Three cases needed opening of palmar skin up to the proximal phalanx of the thumb as tunneling was inadequate to negotiate MP joint region(because of larger width flap >2.5cm) . The tourniquet was then released to check for adequate flap perfusion and to secure hemostasis. No anatomical variation was observed. Four patients needed incision on palmar aponeurosis for tension free suturing of the flap. Superficial palmar arch division and pivot point shifting was not done in any of the patients. Flap Inset was given without tension by suturing with 4-0 nylon. In two patients the dorsal branch of the digital nerve taken along with the flap was transected and sutured to digital nerve of thumb. In two patients with soft tissue loss and digital nerve loss over proximal phalanx neurovascular island flap done. In the above two cases digital nerve sutured to distal thumb nerve on terminal phalanx.

Donor site was covered with split-thickness skin graft harvested from ipsilateral medal side arm and a tie over dressing applied. Staggering of donor margin was not done in any our patients. Short aluminum splint was applied for mid finger and dorsal thumb POP applied. In eight patients in whom the thumb had been reconstructed by a tubed pedicle and bone graft, the neurovascular flap was designed from the ulnar half of the proximal and middle phalanx region of the middle finger.

Post operative instructions:

Flap viability was checked periodically. Donor site first dressing was changed on the 5th postoperative day. POP and suture were removed on 10th post operative day. Night Finger straightening splint applied from the 10th post op day and advised to continue for 6 months. Skin graft massage and Scar massage done with Lanolin for 6 months. Physiotherapy started by active and passive mobilization of finger were carried out to prevent contracture. Early return to work was encouraged.

Osteoplastic Reconstruction:

We operated 8 cases of osteoplastic reconstruction of thumb with neurovascular island flap transfer. This technique requires multiple stages.

Preparation of a tube pedicle flap-It was necessary to fashion a flap of a suitable length. Tubed Groin flap was used in all cases of thumb reconstruction. During this procedure the longitudinal suture line of the tube was should be on volar surface, as it can be opened for that the island flap transfer at a later date. *Separation of the tube* was done three weeks later. *Incorporation of the bone graft and neuronascular island flap transfer*- This was performed after complete maturation of the tube. (After 3 months). It consists of three stages: 1) *Opening of the tube.* The tube was opened along the line of the suture exposing the end of the bone stump into which a bone graft is to be placed. 2) *Incorporation of the bone graft.* The graft was usually taken from the ulna. It was fixed by incorporation the tip of the tapered graft into the medullary canal of the proximal bone stump (pegging the graft). The length of the graft and of the reconstructed thumb depends on the site of amputation. The

aim was to provide a thumb sufficiently long to allow easy opposition. As it has no joint, the thumb must be a little shorter than normal. 3) *Transfer of the island flap.* The procedure was the same as described for the soft tissue loss of the thumb except that it should be smaller- two centimeters long and about one to two centimeters broad. The neurovascular skin flap was brought along the line of previous suture line allowing easy closure after the bone graft has been fixed. The reconstructed thumb was immobilized in plaster-of-Paris for about three weeks. The result in these eight patients has been satisfactory for prehension and sensibility. The vascularity was also improved. The transfer of a good blood supply was probably the explanation of the rapid consolidation of the bone graft and the lack of tropic changes. Any osteoplastic reconstruction of the thumb already performed can be benefited by the transfer of such a neurovascular island flap.

There were no operative failures. The flap survived in all 42 patients. Only one complication occurred during the operation. The digital nerve was cut while dissecting the neurovascular bundle to the ring finger. The nerve was repaired and the island flap was taken from the mid finger. In each patient the sensation, vascularity, and durability of the flap was assessed. We inquired about any specific complaints and their significance. Any disability of the donor finger was also noted.

Donor finger:

Any contracture of the donor finger was noted. Range of movement was checked at MPjoint, PIP joint and DIP joint. Extensor lag was measured. Sensation on the donor finger was assessed on ipsilateral side as that side digital nerve was removed. Return of sensation on SSG or any areas of hyperesthesia were also noted. Any tropic changes in distal aspect of finger was noted. Cosmesis on donor finger was questioned.

Thumb Sensation:

Tactile gnosis, touch, and pain were tested.

Tactile gnosis: Tactile gnosis is tested by two point discrimination.

Two-point discrimination (2PD): This is the best test for the evaluation of tactile gnosis in small areas such as grafts and flaps; it is the only method that provides quantitative comparative values. The test was done on all 42 flaps and on normal digits in the manner described by Moberg and Onne. Mannerfelt apparatus was used for assessing twopoint discrimination.

Static two-point discrimination test (Weber 1835 - Tests of the Slowly adapting mechanoreceptors).

Using a Mannerfelt apparatus, either one or two points along the long axis on the finger pulp were stimulated. The distances between the points were 2,4.6,8,10,12,14,16,18 and 20 mm. Two-point stimulation and one-point stimulation were repeated 10 times each and if the patient responded correctly 8 or more times, he was considered to have passed the test.

Moving two-point discrimination (Tests of quickly adapting mechanoreceptors).

Dynamic two point discrimination was tested using the same equipment as for the static 2PD test. The movement was in a lengthwise direction on the finger pulp and the minimum discrimination values were recorded (Dellon 1981).

Picking up test (stereognosis): This was done routinely for all our patients.

Touch and pain: Light touch was tested with the wisp of cotton. The ability to distinguish between the sharp and dull ends of a pin was used to assess pain.

Sensory Reorientation:

Sensory reorientation was assessed for the flap transferred. Hand dominance and duration since surgery were taken into consideration. All patients were right handed. Of the 42 patients operated 16 were operated on left hand. Of 34 neurovascular island flap done for trauma 22 were operated on dominant (right) hand and 12 were operated on nondominant (left) hand. Seventeen cases were operated a year back and rest seventeen were less than a year. Of 8 Neurovascular island flap done for osteoplastic four were operated on dominant (right) hand and four were operated on nondominant (left) hand. Four were operated a year back and rest four were less than a year. Two case of Neurovascular island flap had dorsal branch of digital nerve transected and sutured to thumb digital nerve.

Tinel Sign:

Palm was percussed for any evidence of compression on the nerve.

Durability:

The skin on the volar surface of the thumb is subjected to constant friction and hence must be durable. The flaps were inspected for callus formation, staining, scarring, induration, and trophic changes.

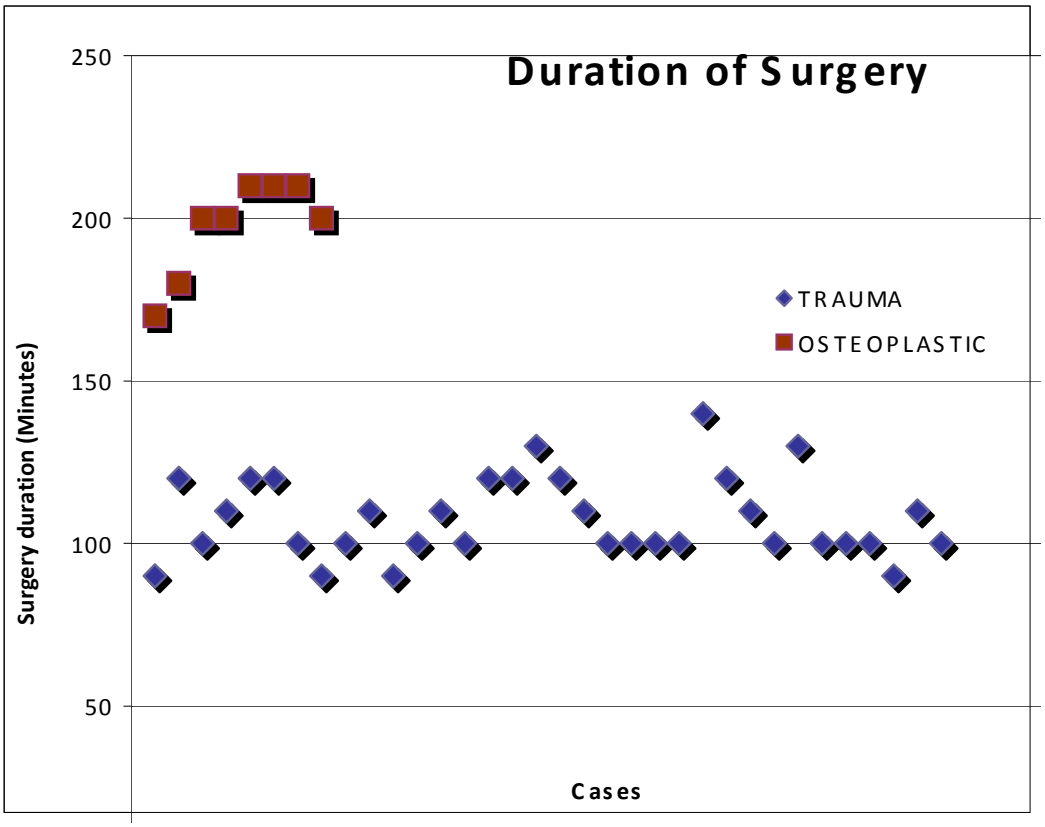
Patients assessment:

Patient were given a questionnaire and assessed.

OBSERVATION

Per operative:

No intraoperative anatomical variation were observed during neurovascular pedicle dissection. Average time taken for during neurovascular island flap in trauma was around 105 minutes. In osteoplastic reconstruction duration was around 200 minutes as bone graft also done in the same sitting. All flaps were found to be viable at the end of surgery.



***Donor finger**:*

Split skin graft applied on the donor finger settled well. All patients developed protective sensation on donor finger except two who reported hyperesthesia which did not disturb work or daily activities. One patient developed PIP joint fixed flexion contracture as the patient did not follow our post op advice of wearing finger straightening splint, lanolin massage and physiotherapy. In four cases in which dorsal branch of digital nerve was preserved while taking neurovascular island flap had no loss of sensation at finger tip on the flap side. Two cases of neurovascular island flap done in which dorsal branch of digital nerve was repaired to digital nerve of the thumb attained good sensory reorientation and two point discrimination of 4mm.

To evaluate Flexion contracture of donor finger and to standardize and compare results, based on total active motion (TAM) Strickland system used. The formula is

(PIP + DIP) flexion − extension deficit × 100/175degrees = %normal

Case Number	PIP JT DEGREE	DIP JT DEGREE	EXT LAG DEG	STRICKAND Value
1	0-105	0-65	0	97.14
2	0-105	0-65	0	97.14
3	0-105	0-70	0	97.14
4	0-105	0-70	0	100
5	0-105	0-70	0	100
6	0-105	0-70	0	100
7	0-105	0-70	0	100
8	0-105	0-70	0	100
9	0-105	0-70	0	100
10	0-105	0-65	0	97.14

Case Number	PIP JT DEGREE	DIP JT DEGREE	EXT LAG DEG	STRICKAND Value
11	0-105	0-70	0	100
12	0-105	0-70	0	100
13	0-105	0-70	0	100
14	0-105	0-70	0	100
15	0-105	0-70	0	100
16	0-105	0-70	0	100
17	0-105	0-70	0	100
18	0-105	0-65	0	97.14
19	0-100	0-70	0	97.14
20	0-105	0-65	0	97.14
21	0-105	0-70	0	100
22	0-105	0-70	0	100
23	0-105	0-65	0	97.14
24	0-105	0-70	0	100
25	0-105	0-70	0	100
26	0-105	0-70	0	100
27	0-105	0-70	0	100
28	0-105	0-70	0	100
29	0-105	0-70	0	100
30	**90 FFD**	**0 - 10**	**20**	**45.71**
31	0-105	0-70	0	100
32	0-105	0-70	0	100
33	0-105	0-70	0	100
34	0-105	0-70	0	100
35	0-105	0-70	0	100
36	0-105	0-65	0	97.14
37	0-105	0-65	0	97.14
38	0-105	0-65	0	97.14
39	0-105	0-70	0	100
40	0-105	0-70	0	100
41	0-105	0-70	0	100
42	0-105	0-70	0	100

All the cases were found to be in excellent result except for one patient with fixed flexion contracture, which had 45% (Poor) Value.

THUMB:

Sensory reorientation:

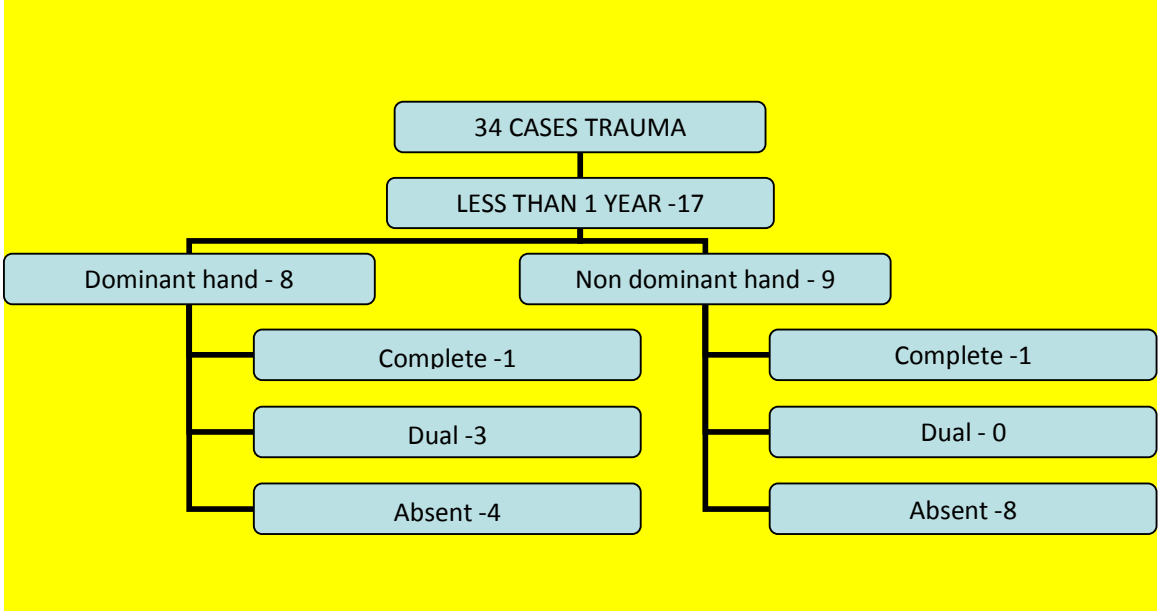
Of 34 the Neurovascular island flap done for trauma 22 were operated on dominant (right) hand and 12 were operated on nondominant (left) hand. Seventeen were operated a year back and rest seventeen less than a year.

Perception of sensory reorientation (done with eyes closed) is classified as

1. Complete – wherein patient identifies flap as thumb
2. Dual – wherein patient identifies flap as thumb and donor finger
3. Absent – wherein patient identified flap as donor finger

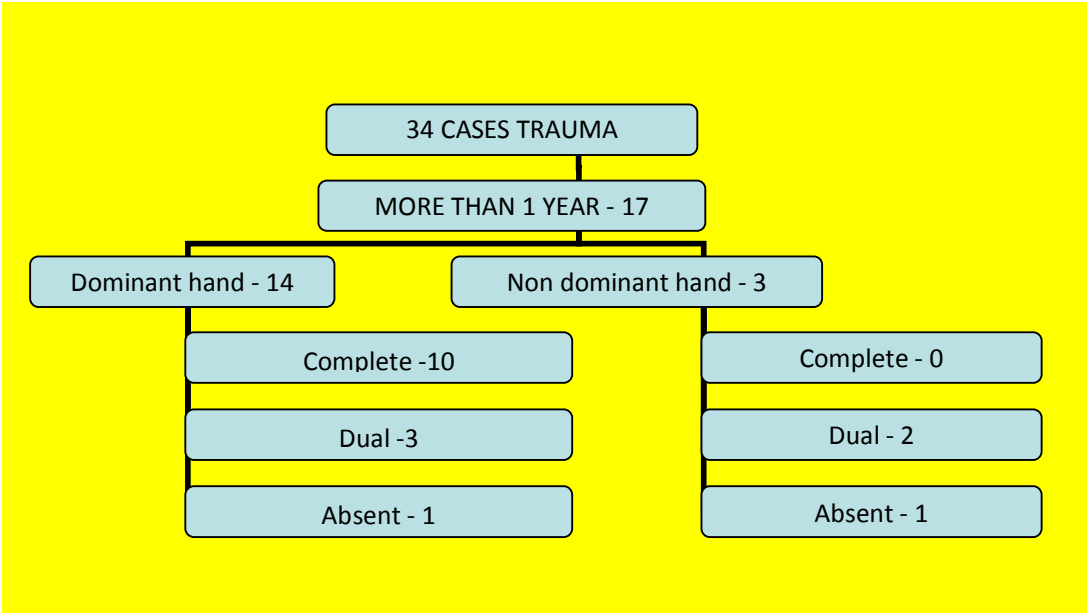
Of the eight cases operated on the dominant hand in less than a year four patients did not develop sensory reorientation, three had dual orientation and one case had complete reorientation. In the case of complete orientation dorsal branch of digital nerve was sutured to the thumb digital nerve at proximal phalanx level.

Of the nine cases operated on the nondominant hand in less than a year eight patients did not develop sensory reorientation and one case had complete reorientation. In the case of complete orientation dorsal branch of digital nerve was sutured to the thumb digital nerve at proximal phalanx level.



Of the fourteen cases operated on the dominant hand more than a year ago three had dual orientation, one no sensory reorientation and ten cases had complete reorientation

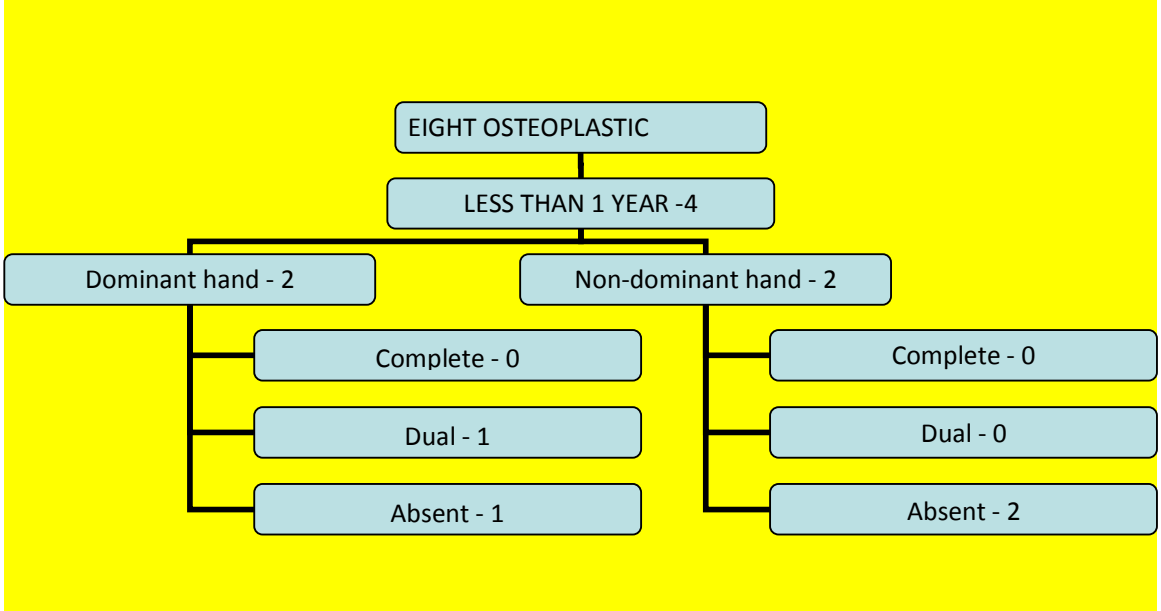
Of the three cases operated on the nondominant hand more than a year ago one patient did not develop sensory reorientation and two cases had dual sensory reorientation.



Of the eight Neurovascular island flaps done for osteoplastic thumb four were operated on dominant (right) hand and four were operated on nondominant (left) hand. Four were operated a year back and the other four less than a year.

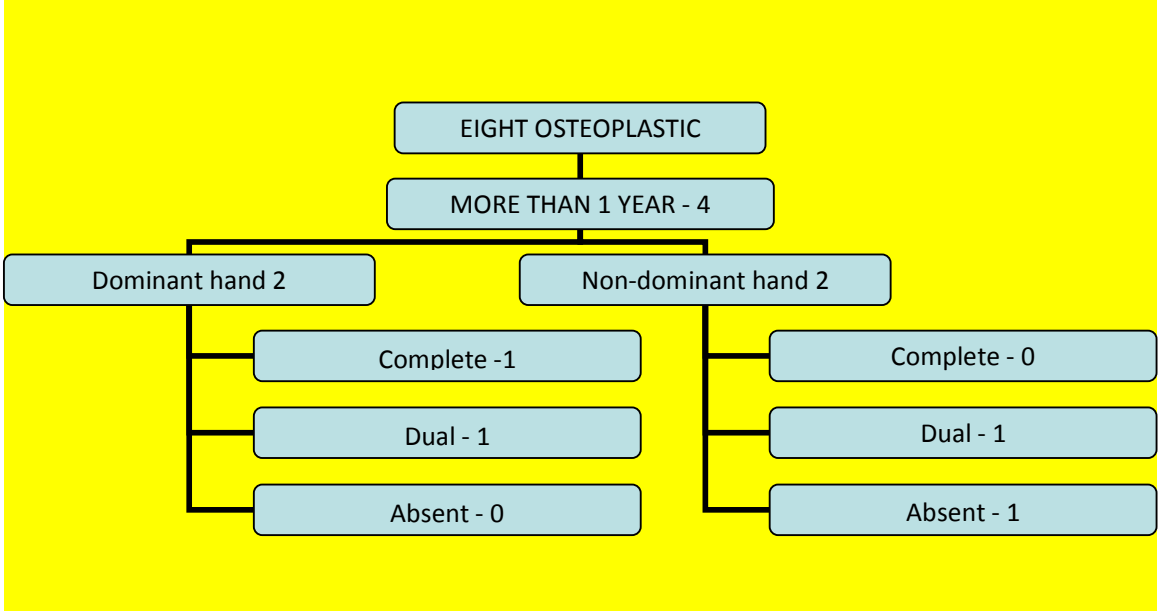
Of the two cases operated on the dominant hand in less than a year one patient did not develop sensory reorientation and other had dual orientation.

Of the two cases operated on the nondominant hand in less than a year no case develop sensory reorientation.



Of the two cases operated on the dominant hand more than a year ago one patient had complete sensory reorientation and other had dual orientation.

Of the two cases operated on the nondominant hand more than a year ago one patient did not develop sensory reorientation and other had dual orientation.



Difference in sensory reorientation between flap taken from mid and ring finger could not be tested in this study as flaps from ring finger were done in last 6 months only.

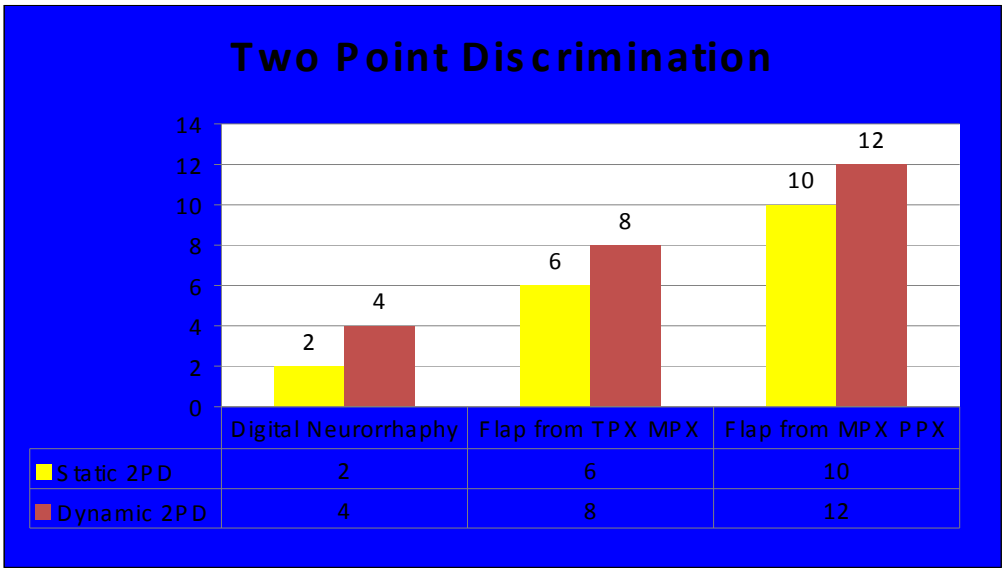
There is no difference in sensory reorientation observed between the cases of traumatic and osteoplastic reconstructions.

Two Point Discrimination:

When flap was taken from middle and proximal phalanx static two point discrimination, is around 12mm to 14 mm and dynamic two point discrimination is around 10 to 12mm. When was flap taken from terminal and middle phalanx static two point discrimination, is around 8mm and dynamic two point discrimination is around 6mm. Opposite side normal thumb had two point discrimination of 2mm. In osteoplastic reconstruction groin flap had two point discrimination of 42 to 54mm.

In two cases where dorsal branch of digital nerve transected and sutured with proximal digital nerve in thumb static two point discrimination is 4mm and dynamic two point discrimination is 2mm.

Transferring more skin from volar surface had better two point discrimination.



Pain **-** It was noted whether the patient could discriminate between sharp and blunt pressure in the flap area and just outside the flap. All patients could identify the pain.

Touch **-** It was noted whether the patient could discriminate contact with the with wisp of cotton in the flap area and just outside the flap. All patients could identify the touch.

Temperature **-** It was noted whether the patient could distinguish lukewarm and cold water in the flap area and just outside the flap in all cases. Present in all cases.

Signs of nerve compression **-** Tinel's sign was absent in the pedicle area in all the cases.

Trophic changes **-** The thumb and the donor finger were checked for signs of atrophy. It was obvious that the island flap transfer had provided a vascular augmentation and durable skin with considerable improvement of the vascularity condition of the thumbs covered by distant flaps. Blood flow through the vascular pedicle was tested by blushing in the exsanguinated thumb after the release of digital pressure over the pedicle during follow up. No obstruction in the blood flow could be elicited as late as two years.

Cold intolerance **-** The patients were asked whether the flap transfer had influenced cold intolerance in the thumb or the donor finger. No patients had cold intolerance in the thumb or donor finger. This may be due to warm climate in our area.

Callosity formation **-** This was present in the margin of the flap on thumb in two patients and was a minor nuisance.

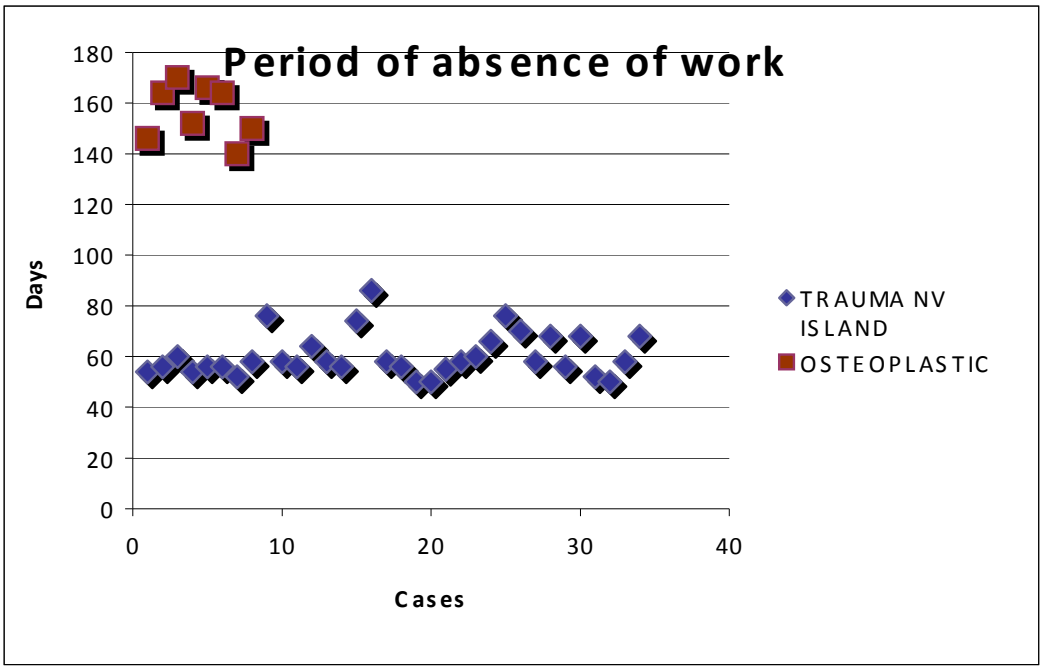
Pick-up tests **-** These were performed without the patient's visual control. One patient had poor result.

Dimension of the flap area **–** In cases of trauma flap measured average of 2.8cm by 2.1cm (Range3.5cm to 2cm /3cm to 1.6cm). In osteoplastic reconstruction flap measured average of 2cm by 1.6cm. (Range 2.2cm to 2cm / 1.8 to 1.4cm).

Bulky Flap **-** Out of 8 osteoplastic reconstruction done seven complained of bulky flap attributed to groin component of flap. Out of 34 cases of neurovascular island flap done cases 18 cases complained of bulky flap. But when flap thinning was offered. Flap thinning not taken by the patient.

Neuroma Thumb **-** Two cases had painful neuroma on thumb at the base of the flap. But it does not have any major hindrances to daily work.

Returning back to work – Average duration for neurovascular island flap done cases was 2 months and for Osteoplastic reconstruction was 5 months.



DISCUSSION OF RESULTS

Functional improvement was obtained in all 42 patients. The flap transfers provided a blood supply, durable skin cover and protective sensibility. This was reflected in all patients by the colour and texture of their thumbs, and confirmed by the fact that all 42 patients returned to pre injury work. From a clinical point of view the results presented are encouraging, as two-point discrimination was less than 15mm and consistently same in follow up. Experience has shown that useful tactile gnosis is correlated to the finding of 2 PD < 15 millimeters (Moberg 1966), a fact that was reflected in the performance of the pick-up test. The two point discrimination improved to near normal when dorsal branch of digital nerve was transected and sutured to thumb digital nerve(Lee PRS Oct 2006). Increase in 2 PD could be due to factors such as fibrosis from the scar tissue or repetitive minor trauma to the palm with subsequent pedicle compression must have played a part. Sensory reorientation is better after one year of surgery and dominant hands have complete sensory reorientation. Experience has shown that sensibility can be improved by prolonged exercises, such as with the blind learning Braille, and after nerve injury (Dellon, Curtis and Edgerton 1971). Most of the patients in this study returned to work in two months time and actively used their thumb which could be the reason for early sensory reorientation. The dominant hand had good sensory reorientation as this being the hand more frequently used (Krag.C 1975). Differences in sensory reorientation between flap taken from mid and ring finger could not be tested in this study as ring finger flaps were done only in last 6 months.

Hypersensitivity of the flap occurred in two patients, but not to a degree necessitating denervation as reported by Murray *et al.* (1967). Loss of the neurovascular island flap from vascular insufficiency, as reported by McGregor (1969), did not occur. This could be because of adequate precautions taken during flap dissection and if needed division of palmar aponeurosis for tension free inset. The complaints of cold intolerance were not reported in any of our patients, this may be because of consistently warm climate. Troubles necessitating amputation of the donor finger, as reported by Moberg (1969), did not happen. Twenty five patients complained of bulky flap but when flap thinning was advised none was willing. No significant difference was observed in two point discrimination between a flap taken from ring or mid finger. When flap is taken distally from terminal phalanx better two point discrimination observed. The operation also provides the durable sweat-producing, cornified skin that is so essential on the distal thumb.

Dorsal branch of Digital Nerve preservation retains sensation to tip of donor finger on ipsilateral side(Ali 1998). Full thickness skin graft was used for donor site coverage in most of the cases in literature. But we use split thickness skin graft and give proper care by finger straightening splint, graft massage with lanolin and early mobilization of fingers.

Restoration of the five components of thumb function described by Littler—stability, strength, mobility, sensibility, and posture—was the basis for our reconstructive plan while doing osteoplastic reconstruction. All the cases of osteoplastic reconstruction were fulfilling the above said criteria.

CONCLUSION

- Most common cause is industrial accident
- Most commonly involved in the age group between 20 to 40 yrs.
- Males most commonly injured.(M:F=40:2)
- Right thumb was commonly injured.(R:L=26:16)
- Donor finger contracture was avoided by proper post operative splinting.
- Preservation of dorsal branch of digital nerve retains sensation at finger tip in the ipsilateral side of donor finger.
- Cold intolerance was not seen in any of our patients because of warm climate.
- Two point discrimination over the transferred flap is less than 15mm which is necessary for manual work. (Moberg, 1966).
- Two point discrimination improved if flap was taken as distally as possible.
- Good sensory reorientation was achieved one year after surgery.
- Dominant hand regains good sensory reorientation.
- If dorsal branch of digital nerve was transected and repaired to thumb digital nerve, sensory reorientation was better and two point discrimination was improved. This is useful when the patient is skilled professional like software engineer, musician.
- Appearance of donor finger is acceptable for our patients.

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PATIENT QUESTIONNAIRE

1. Did you join back to your work?
2. How long you took to join back to the work?
3. Do you have hyperesthesia on flap?
4. Do you have hyperesthesia on donor graft site?
5. Do you feel numbness on donor finger?
6. Do you use thumb in your job work?
7. Are you following up our postop advice?
8. Are you happy with reconstruction?
9. Are able to appreciate your thumb as thumb?
10. Are you able to do all daily activities with hand?
11. Do you have any specific query regarding your reconstruction?
12. Is your finger and thumb cosmetically good?

NV ISLAND FLAP FOR THUMB

FOLLOW UP - IRRH & DPS, SMC

NAME AGE SEX OCCUPATON	
SIDE DOMINANT HAND	
NATURE OF INJURY	
INDICATION FOR FLAP COVER	TRAUMA ELECTIVE
DEFECT SIZE RING OR MID RAD/ULNAR	
INTRA OP	ANATOMICAL VARIATION FLAP VIABILTY 1. AFTER TOURNIQUE RELEASE 2. AFTER TUNNELING

IMMEDIATE POST OP	1. GRAFT LOSS 2. FLAP LOSS
FOLLOW UP DONOR FINGER	1. SKINCONTRACTURE 2. SSG HEALING 3. SENSATION OVER SSG (HYPERESTHESIA) 4. SENSATION DISTALLY (TIP) 5. JOINT MOVEMENT (MP JT, PIP JT, DIP JT, EXT LAG) 6. TROPHIC ULCER 7. COLD INTOLERANCE
PALM	• TINEL SIGN
THUMB	1. PERCEPTION AS THUMB 2. FLAP SURVIVAL 3. HYPERKERATOSIS AT JUNCTON 4. THUMB CONTRACTURE 5. PICKUP TEST 6. COLD INTOLERANCE 7. TWO POINT DISCRIMNATION (FLAP & NORMAL THUMB) • S2PD • M2PD

NEUROVASCULAR ISLAND FLAP FOR TRAUMA

Num	Name	Ps no	Date surgery	Age	Sex	Side	Donor finger	Site
1.	NARESH	E/1565/H/08	03/03/08	21	M	L	Mid	TPX & MPX
2.	BALASUNDARAM	E/1434/H/08	27/02/08	23	M	L	Mid	TPX & MPX
3.	SUNDHAR	E/1251/H/08	20/02/08	39	M	R	Ring	TPX & MPX
4.	ANTONY	E/770/H/08	02/02/08	37	M	L	Mid	MPX & PPX
5.	MURUGAN	E/9174/H/07	14/12/07	20	M	R	Mid	TPX & MPX
6.	RAVISHANKAR	E/9139/H/07	12/12/07	24	M	R	Mid	TPX & MPX
7.	RAVI	OP/3750/H/07	22/11/07	34	M	L	Mid	TPX & MPX
8.	MARY	E/8119/H/07	02/11/07	28	F	R	Mid	MPX & PPX
9.	RAJINI	E/7522/H/07	10/10/07	24	M	L	Mid	TPX & MPX
10.	MOHAMAD ALI	E/7523/H/07	10/10/07	22	M	L	Ring	TPX & MPX
11.	SANTOSH	E/7470/H/07	08/10/07	19	M	R	Ring	MPX & PPX
12.	DANASEKAR	OP/3109/H/07	20/09/07	30	M	R	Mid	MPX & PPX
13.	SANKAR	E/6630/H/07	07/09/07	55	M	L	Mid	MPX & PPX
14.	RADHAKRISHNAN	E/6501/H/07	02/09/07	49	M	R	Mid	MPX & PPX
15.	ANBALAGHAN	E/6492/H/07	02/09/07	55	M	L	Mid	MPX & PPX
16.	ALAGU	E/5420/H/07	22/07/07	52	M	L	Mid	MPX & PPX
17.	TAPAN	E/3765/H/07	14/05//07	38	M	R	Mid	MPX & PPX
18.	ALOTH KUMAR	OP/831/H/07	21/04/07	21	M	R	Mid	MPX & PPX
19.	SANTHARAJ	E/2243/H/07	28/03/07	23	M	R	Mid	MPX & PPX
20.	JAYASURIYA	OP/450/H/07	31/01/07	9	M	R	Mid	MPX & PPX
21.	JOHNSON	E/25/H/07	02/01/07	37	M	R	Mid	MPX & PPX
22.	ARUMUGHAM	OP/2839/H/06	11/11/06	32	M	R	Mid	MPX & PPX
23.	MANIKANDAN	E/6701/H/06	22/09/06	24	M	L	Mid	MPX & PPX
24.	SRINIVASAN	E/5892/H/06	22/08/06	49	M	R	Mid	MPX & PPX
25.	GAJENDRAN	E/4983/H/06	18/07/07	34	M	R	Mid	MPX & PPX
26.	AMBIKA	E/4418/H/06	24/06/06	23	F	R	Mid	MPX & PPX
27.	SUNDRAMOORTHI	OP/1756/H/06	29/06/06	37	M	R	Mid	MPX & PPX
28.	ARUN KUMAR	OP/1605/H/06	01/06/06	14	M	L	Mid	MPX & PPX
29.	GOVINDAN	E/3491/H/06	21/05/06	24	M	L	Mid	MPX & PPX
30.	SUNDARESAN	E/2977/H/06	02/05/06	10	M	R	Mid	MPX & PPX
31.	CHANDRAN	E/2341/H/06	08/04/06	48	M	R	Mid	MPX & PPX
32.	DHANASEKAR	E/2065/H/06	27/03/06	43	M	R	Mid	MPX & PPX
33.	MURALI	E/780/H/06	02/02/06	24	M	R	Mid	MPX & PPX
34.	AVTAR SINGH	251621	14/12/05	23	M	R	Mid	MPX & PPX

NEUROVASCULAR ISLAND FOR OSTEOPLASTIC

Num	Name	Ps No	Date Surgery	Age	Sex	Side	Donor Finger	Site
35.	MADANKUMAR	OP/1978/H/07	27/11/07	19	M	R	Mid	MPX & PPX
36.	CHANDRAN	E/1565/H/07	25/09/07	20	M	L	Mid	MPX & PPX
37.	SATHYAMOORTHI	E/983/H/07	22/09/07	20	M	R	Mid	MPX & PPX
38.	ELUMALAI	E/6812/H/06	14/06/07	25	M	L	Mid	MPX & PPX
39.	SENTHIL KUMAR	E/6071/H/06	21/04/07	27	M	L	Mid	MPX & PPX
40.	RAVI	E/4030/H/06	05/12/06	46	M	R	Mid	MPX & PPX
41.	SENTHIL KUMAR	OP/1617/H/06	31/10/06	23	M	L	Mid	MPX & PPX
42.	RIZWAN BASHA	OP/687/H/06	23/03/06	39	M	R	Mid	MPX & PPX

INTRAOPERATIVE FINDINGS AND RESULTS ON DONOR FINGER

NUM	Flap size (cms)	Dorsal branch Preserved	Palmar aponeurosis division	Flap tunneling	Dividing sup palmar arch	Dorsal branch nerve repair to thumb	Time (min)	Flap survival	Venous Congestion	Donor Finger Contracture	Sensation on SSG	Trophic changes	Finger Tip Sensation
1.	2.0 x 2.0	Yes	No	Subcut	No	No	90	YES	No	No	Protective	No	No
2.	2.4 X 2.2	No	No	Subcut	No	No	120	YES	No	No	Protective	No	No
3.	2.6 X 2.4	Yes	Yes	Subcut	No	No	100	YES	No	No	Protective	No	Yes
4.	2.5 X 2.0	No	No	Subcut	No	Yes	110	YES	No	No	Protective	No	No
5.	3.0 X 2.0	No	No	Subcut	No	No	120	YES	No	No	Protective	No	No
6.	3.0 X 2.2	No	No	Subcut	No	No	120	YES	No	No	Protective	No	No
7.	2.8 X 2.0	No	No	Subcut	No	No	100	YES	No	No	Protective	No	No
8.	2.6 X 2.0	No	No	Subcut	No	Yes	90	YES	No	No	Protective	No	No
9.	3.5 X 3.0	No	No	Open Skin	No	No	100	YES	No	No	Protective	No	No
10.	3.4 X 2.2	Yes	Yes	Subcut	No	No	110	YES	No	No	Hypersensi	No	Yes
11.	3.2 X 2.4	Yes	No	Subcut	No	No	90	YES	No	No	Protective	No	Yes
12.	3.0 X 2.2	No	No	Subcut	No	No	100	YES	No	No	Protective	No	No
13.	2.6 X 2.2	No	No	Subcut	No	No	110	YES	No	No	Protective	No	No
14.	2.8 X 2.4	No	No	Subcut	No	No	100	YES	No	No	Protective	No	No
15.	2.4 X 2.2	No	No	Subcut	No	No	120	YES	No	No	Protective	No	No
16.	3.4 X 2.4	No	No	Subcut	No	No	120	YES	No	No	Protective	No	No
17.	3.4 X 2.0	No	No	Subcut	No	No	130	YES	No	No	Protective	No	No
18.	3.2 X 2.8	No	Yes	Open skin	No	No	120	YES	No	No	Protective	No	No
19.	2.5 X 2.0	No	No	Subcut	No	No	110	YES	No	No	Protective	No	No
20.	2.5 X 2.2	No	No	Subcut	No	No	100	YES	No	No	Hypersensi	No	No

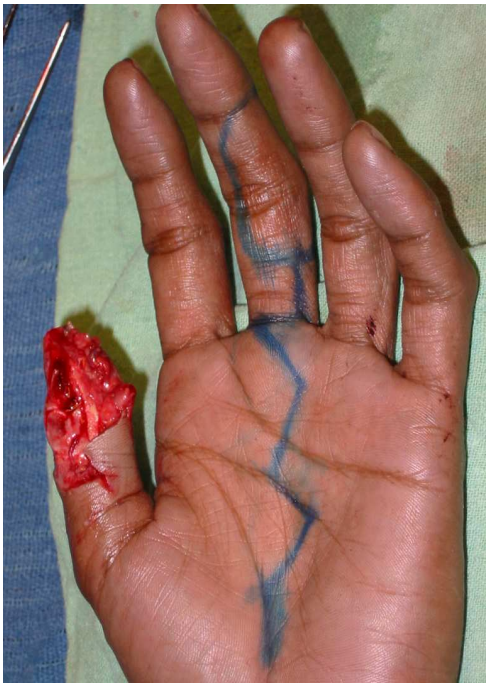
NUM	Flap size (cms)	Dorsal branch Preserved	Palmar aponeurosis division	Flap tunneling	Dividing sup palmar arch	Dorsal branch nerve repair to thumb	Time (min)	Flap survival	Venous Congestion	Donor Finger Contracture	Sensation on SSG	Trophic changes	Finger Tip Sensation
21.	2.8 X 2.0	No	Yes	Subcut	No	No	100	YES	No	No	Protective	No	No
22.	3.2 X 2.4	No	Yes	Subcut	No	No	100	YES	No	No	Protective	No	No
23.	2.4 X 1.8	No	No	Subcut	No	No	100	YES	No	No	Protective	No	No
24.	2.6 X 2.0	No	No	Subcut	No	No	140	YES	No	No	Protective	No	No
25.	3.5 X 2.2	No	No	Subcut	No	No	120	YES	No	No	Protective	No	No
26.	2.2 X 1.6	No	Yes	Subcut	No	No	110	YES	No	No	Protective	No	No
27.	2.8 X 1.6	No	No	Subcut	No	No	100	YES	No	No	Protective	No	No
28.	3.4 X 3.0	No	No	Open skin	No	No	130	YES	No	No	Protective	No	No
29.	3.0 X 2.0	No	No	Subcut	No	No	100	YES	No	No	Protective	No	No
30.	2.8 X 2.2	No	No	Subcut	No	No	100	YES	No	Yes	Protective	No	No
31.	3.4 X 2.2	No	No	Subcut	No	No	100	YES	No	No	Protective	No	No
32.	3.2 X 2.4	No	No	Subcut	No	No	90	YES	No	No	Protective	No	No
33.	3.0 X 2.4	No	No	Subcut	No	No	110	YES	No	No	Protective	No	No
34.	2.8 X 2.2	No	No	Subcut	No	No	100	YES	No	No	Protective	No	No
35.	2.0 X 1.6	No	No	Subcut	No	No	170	YES	No	No	Protective	No	No
36.	2.0 X 1.4	No	No	Subcut	No	No	180	YES	No	No	Protective	No	No
37.	2.2 X 1.6	No	No	Subcut	No	No	200	YES	No	No	Protective	No	No
38.	2.2 X 1.4	No	No	Subcut	No	No	200	YES	No	No	Protective	No	No
39.	2.0 X 1.8	No	No	Subcut	No	No	210	YES	No	No	Protective	No	No
40.	2.2 X 1.6	No	No	Subcut	No	No	210	YES	No	No	Protective	No	No
41.	2.0 X 1.4	No	No	Subcut	No	No	210	YES	No	No	Protective	No	No
42.	2.0 X 1.8	No	No	Subcut	No	No	200	YES	No	No	Protective	No	No

RESULTS ON THUMB

NUM	Reorient	2PD(mm) Static FLAP	Dynamic	Other NORMAL	Neuroma	Pickup test	Pain	Touch	Temp	Cold intol	Callosity	Tinel Sign	Bulky flap	Work Days
1.	Absent	8	6	2	No	Good	Yes	Yes	Yes	No	No	Absent	Yes	54
2.	Absent	8	6	2	No	Good	Yes	Yes	Yes	No	No	Absent	No	56
3.	Absent	8	6	2	No	Good	Yes	Yes	Yes	No	No	Absent	Yes	60
4.	Complete	4	2	2	No	Good	Yes	Yes	Yes	No	No	Absent	No	54
5.	Absent	10	8	2	No	Good	Yes	Yes	Yes	No	No	Absent	No	56
6.	Absent	8	6	2	No	Good	Yes	Yes	Yes	No	No	Absent	Yes	56
7.	Absent	8	6	2	No	Good	Yes	Yes	Yes	No	No	Absent	Yes	52
8.	Complete	4	2	2	No	Good	Yes	Yes	Yes	No	No	Absent	No	58
9.	Absent	8	6	2	No	Good	Yes	Yes	Yes	No	No	Absent	No	76
10.	Absent	14	12	2	No	Good	Yes	Yes	Yes	No	No	Absent	Yes	58
11.	Absent	12	10	2	Yes	Good	Yes	Yes	Yes	No	No	Absent	No	56
12.	Dual	12	10	2	No	Good	Yes	Yes	Yes	No	No	Absent	No	64
13.	Absent	12	08	2	No	Good	Yes	Yes	Yes	No	No	Absent	Yes	58
14.	Dual	12	10	2	No	Good	Yes	Yes	Yes	No	No	Absent	No	56
15.	Absent	14	10	2	No	Good	Yes	Yes	Yes	No	No	Absent	Nos	74
16.	Absent	12	08	2	No	Good	Yes	Yes	Yes	No	No	Absent	No	86
17.	Dual	12	10	2	No	Good	Yes	Yes	Yes	No	Yes	Absent	Yes	58
18.	Dual	14	10	2	Yes	Good	Yes	Yes	Yes	No	No	Absent	Yes	56
19.	Dual	12	10	2	No	Good	Yes	Yes	Yes	No	No	Absent	No	50
20.	Complete	12	10	2	No	Good	Yes	Yes	Yes	No	No	Absent	Yes	50
21.	Complete	14	12	2	No	Good	Yes	Yes	Yes	No	No	Absent	No	55
22.	Dual	12	10	2	No	Good	Yes	Yes	Yes	No	No	Absent	No	58
23.	Absent	14	10	2	No	Good	Yes	Yes	Yes	No	No	Absent	Yes	60
24.	Complete	12	08	2	No	Good	Yes	Yes	Yes	No	No	Absent	Yes	66
25.	Complete	14	10	2	No	Good	Yes	Yes	Yes	No	No	Absent	Yes	76

26.	Complete	12	10	2	No	Good	Yes	Yes	Yes	No	No	Absent	No	70
27.	Complete	14	12	2	No	Good	Yes	Yes	Yes	No	No	Absent	No	58
28.	Dual	12	10	2	No	Good	Yes	Yes	Yes	No	No	Absent	Yes	68
29.	Dual	12	10	2	No	Good	Yes	Yes	Yes	No	No	Absent	Yes	56
30.	Absent	16	14	2	No	Poor	Yes	Yes	Yes	No	No	Absent	Yes	68
31.	Complete	14	12	2	No	Good	Yes	Yes	Yes	No	No	Absent	Yes	52
32.	Complete	12	08	2	No	Good	Yes	Yes	Yes	No	Yes	Absent	Yes	50
33.	Complete	12	10	2	No	Good	Yes	Yes	Yes	No	No	Absent	No	58
34.	Complete	14	10	2	No	Good	Yes	Yes	Yes	No	No	Absent	Yes	68
35.	Absent	12	10	2	No	Good	Yes	Yes	Yes	No	No	Absent	Yes	146
36.	Absent	12	10	2	No	Good	Yes	Yes	Yes	No	No	Absent	Yes	164
37.	Dual	14	10	2	No	Good	Yes	Yes	Yes	No	No	Absent	Yes	170
38.	Absent	14	12	2	No	Good	Yes	Yes	Yes	No	No	Absent	Yes	152
39.	Absent	12	08	2	No	Good	Yes	Yes	Yes	No	No	Absent	Yes	166
40.	Dual	14	10	2	No	Good	Yes	Yes	Yes	No	No	Absent	Yes	164
41.	Dual	12	10	2	No	Good	Yes	Yes	Yes	No	No	Absent	Yes	140
42.	Complete	14	12	2	No	Good	Yes	Yes	Yes	No	No	Absent	No	150

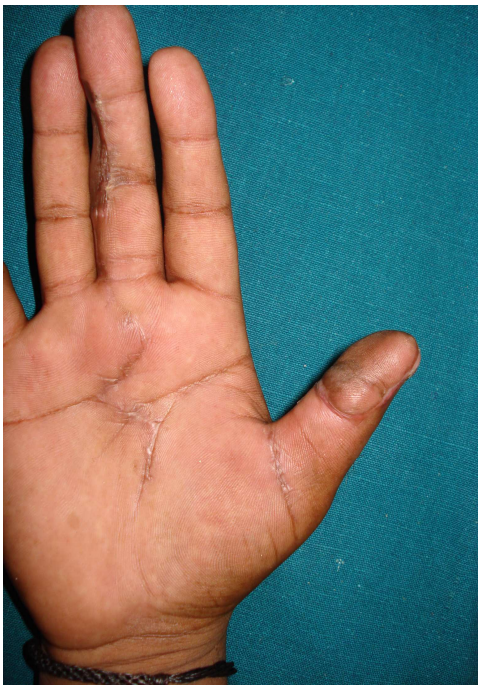
OPERATIVE DETAILS



PROPER DIGITAL NERVE SEPARATION

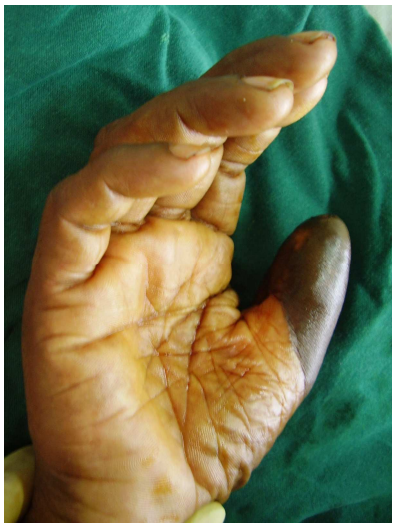
FINGER STRAIGHTENING SPLIT

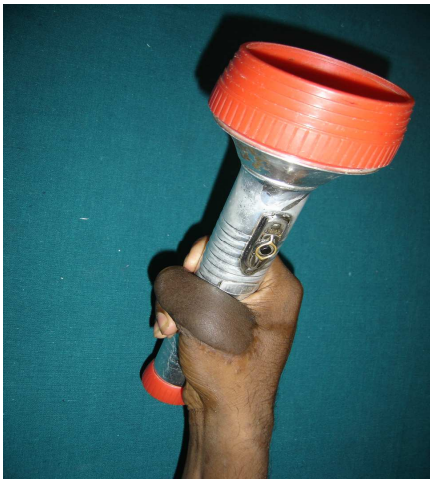
NEUROVASCULAR ISLAND FLAP FOR TRAUMA

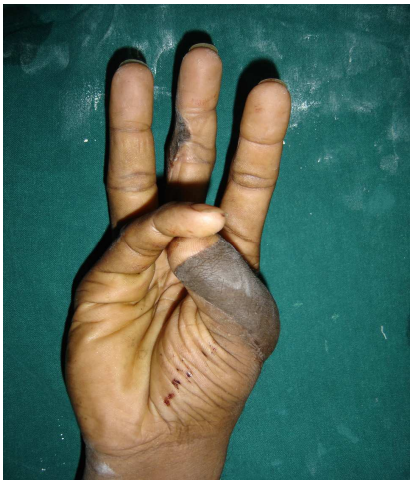


PROXIMAL PHALANX NEUROVASCULAR ISLAND FLAP

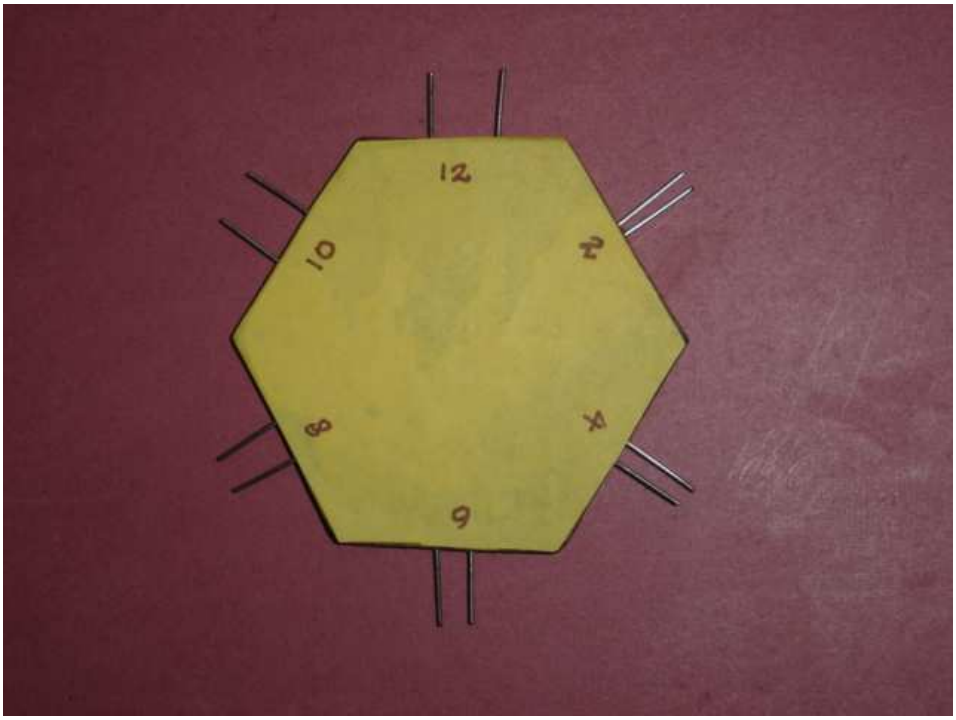
OSTEOPLASTIC NEUROVASCULAR ISLAND FLAP

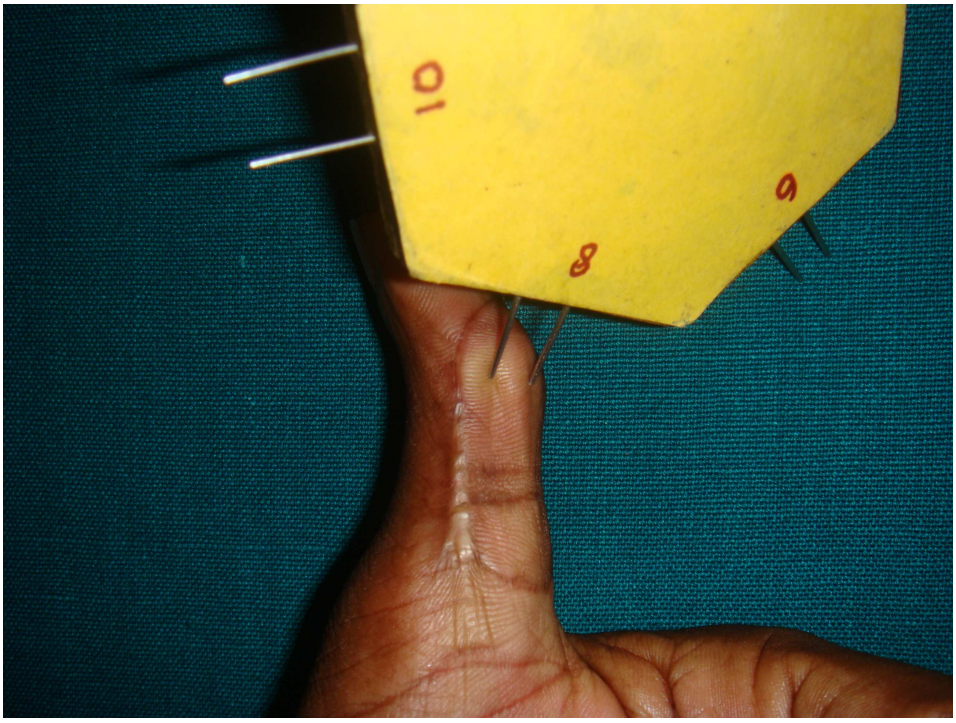




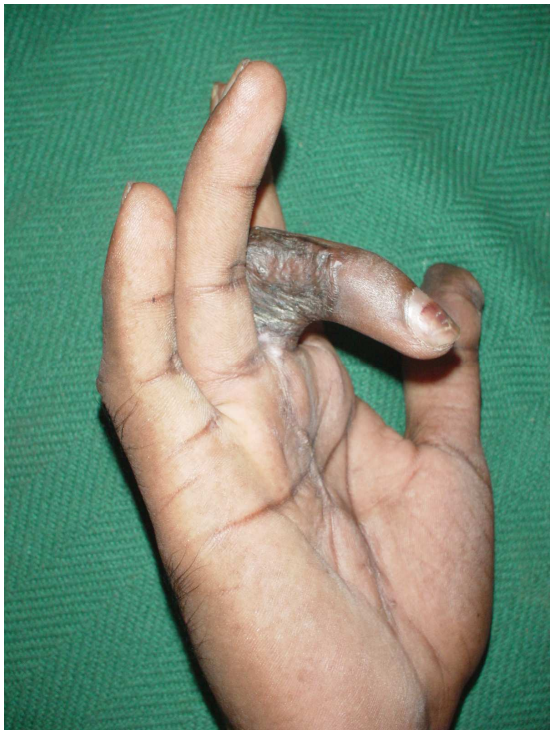


MANNERFELT APARATUS FOR TWO POINT DISCRIMINATION

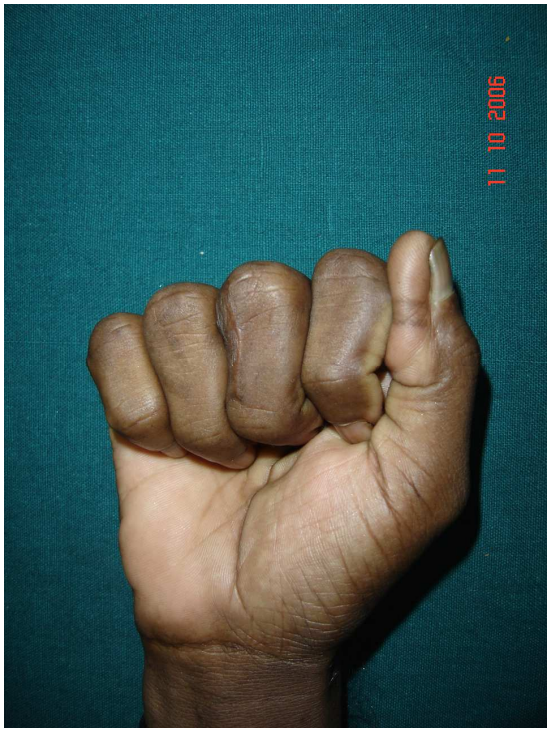




DONOR FINGER CONTRACTURE ONE CASE



NO CONTRACTURE FORTY ONE CASES



LATE RESULT